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INSTITUTS SCIENTIFIQUES DE BUITENZORG  
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# TREUBIA

RECUEIL DE TRAVAUX ZOOLOGIQUES,  
HYDROBIOLOGIQUES ET OCÉANOGRAPHIQUES

RÉDIGÉ PAR

Prof. Dr. W. M. DOCTERS VAN LEEUWEN,

Directeur du Jardin Botanique  
de Buitenzorg,

Dr. K. W. DAMMERMAN,

Chef du Musée et du Laboratoire Zoologiques  
de Buitenzorg,

ET

Prof. Dr. H. C. DELSMAN,

Chef du Laboratoire pour l'exploration de la  
Mer à Batavia.

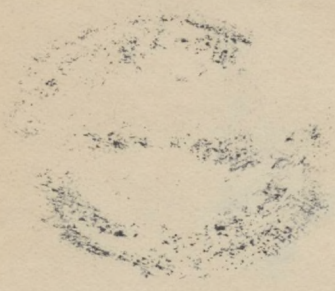
VOLUME XII

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# THE BUMBLEBEES OF JAVA, SUMATRA AND BORNEO

(Bremidae: Hymenoptera)

By

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Illinois State Natural History Survey, Urbana, Illinois.

The present paper is presented as a revisional study of all the species and varieties of bumblebees known to occur in Java, Sumatra and Borneo. In keeping with the scope of this paper, all references in literature concerning the various species and varieties occurring in the East Indies are listed in accordance with the author's ideas of synonymy, old species are redescribed in the light of modern descriptions in this group of social bees, and new descriptions have been prepared where necessary.

I am indebted for the loan of material to the United States National Museum, Washington, D.C., the American Entomological Society, Philadelphia, Pa., the American Museum of Natural History, New York, N.Y., Zoological Museum, Buitenzorg, Java, 's Rijks Museum voor Natuurlijke Historie, Leiden, Holland, and especially the British Museum, London, England. Mr. O. W. RICHARDS of Oxford, England, has graciously prepared and sent to me detailed notes concerning the structural characters of types in the British Museum and supplied much other information of a varied character. For information regarding the existence and present location of other types mentioned in this paper I am indebted to the following: Dr. FRANZ MAIDL, Vienna, Austria; R. VAN EECHE, Leiden, Holland; Dr. HEINRICH FRIESE, Schwerin, Germany; Dr. LUCIEN BERLAND, Paris, France; ANTOINE BALL, Bruxelles, Belgium; Dr. RECHBERG A. SCHULTHESS, Zürich, Switzerland; Dr. ENRICO FESTA, Torino, Italy; and Dr. WALTHER HORN, Berlin, Germany. To Dr. JAMES WATERSTON I am indebted for arranging the loan of material from the British Museum, and to Dr. H. H. KARNY for similar services in connection with the material belonging to the Zoological Museum, Buitenzorg, Java.

Before passing to a consideration of the species involved, it seems that mention should be made of the fact that among the material sent to me for study by the British Museum is a male with an old label on which is written "Sumatra". This male is identical with the male of *Bremus tunicatus* (SMITH), a species known from India and China. In view of the known distribution of *tunicatus* and the lack of additional specimens from Sumatra, I doubt the correctness of the locality label. Therefore, this species has been left out of consideration in this article and not placed in the keys.



For the sake of convenience and clarity I have arranged my subject matter in this paper under the following headings: Keys to species and varieties, sub-generic groupings, new varieties, synonymy and taxonomic notes on previously described species and varieties, geographical summary, and illustrations.

# A. KEYS TO THE SPECIES AND VARIETIES OF *BREMUS* FROM JAVA, SUMATRA AND BORNEO.

## Queens and Workers (Females).

1. Metatarsus of middle leg at apical outer angle with a pronounced, sharp, spine-like projection ..... 2
- Metatarsus of middle leg at apical outer angle without a pronounced, sharp, spine-like projection ..... 5
2. Dorsum of thorax entirely covered with dark pubescence  
*melanopoda* (COCKERELL).
- Dorsum of thorax mostly or entirely covered with white or yellowish-white pubescence ..... 3
3. Dorsum of abdominal segments with at least the first four segments with white pubescence ..... *senex* (VOLLENHOVEN).
- Dorsum of abdominal segments entirely or with some black or dark pubescence on the first two segments ..... 4
4. Dorsum with yellowish-white pubescence on some of the apical abdominal segments ..... *senex* var. *sumatrensis* (COCKERELL).
- Dorsum with dull ferruginous or tawny pubescence on some of the apical abdominal segments ..... *senex* var. *ardentior* (COCKERELL).
5. Dorsal abdominal segments entirely with black pubescence; wings very dark; integument of legs reddish; Java and Sumatra ..... 6
- Dorsal abdominal segments with yellowish, brownish or dull ferruginous pubescence; wings brownish; integument of legs black; Borneo  
*folsoni* FRISON.
6. Dorsum of thorax with black pubescence ..... 7
- Posterior portion of dorsum of thorax (scutellum) with ochraceous pubescence, anterior and middle of thorax with black pubescence  
*rufipes* var. *richardsi* FRISON.
7. Apical dorsal abdominal segments with ferruginous pubescence  
*rufipes* var. *flavipes* (HANDLIRSCH).
- Apical dorsal abdominal segments with dark or black pubescence..... 8
8. Corbicular fringes (hairs fringing pollen basket on hind leg) entirely bright ferruginous ..... *rufipes* (LEPELETIER).
- Corbicular fringes not or but partly bright ferruginous..... 9
9. Basal portion of corbicular fringes black, remainder ferruginous  
*rufipes* var. *intermissus* (FRIESE).
- Corbicular fringes entirely black..... *rufipes* var. *obscuripes* (FRIESE).



## Males

(The Males of *Bremus folsomi*, *B. melanopoda*, and certain color varieties of *B. rufipes* and *B. senex* are not known).

1. Fifth antennal segment at least one and one-half times as long as fourth; malar space distinctly punctate on lower or caudal half; metatarsus of middle leg at apical outer angle strongly produced; heads of sagittae of genitalia somewhat dilated and toothed but not with a sickle-like hook... 2
- Fifth antennal segment not one and one-half times as long as fourth; malar space smooth and shiny, but faintly punctate on lower or caudal half; metatarsus of middle leg at apical outer angle not strongly produced; heads of sagittae of genitalia dilated and with a pronounced sickle-like hook... 3
2. Dorsum of thorax mostly with whitish or hoary pubescence; first four dorsal abdominal segments with traces of whitish or hoary pubescence, particularly on the posterior portions of segments; dorsal apical abdominal segments with considerable tawny or dull ferruginous pubescence  
*senex* var. *ardentior* COCKERELL.
- Dorsum of thorax with disk only with whitish or hoary pubescence, remainder dark or black; first four dorsal abdominal segments entirely covered with black pubescence; dorsal apical abdominal segments with considerable ferruginous or golden-brown pubescence  
*senex* var. *pallidithorax* FRISON.
3. Apical dorsal abdominal segments entirely covered with black pubescence ..... 4
- Apical dorsal abdominal segments with considerable ferruginous pubescence ..... *rufipes* var. *flavipes* (HANDLIRSCH).
4. Corbicular fringes entirely bright ferruginous..... *rufipes* (LEPELETIER).
- Corbicular fringes entirely black..... *rufipes* var. *obscuripes* (FRIESE).

## B. SUBGENERIC GROUPINGS.

**Senexibombus**, subgenus new.

(Type *B. senex* VOLLENHOVEN, 1873, original designation).

*Male*.—Labrum with small areas near each lateral margin smooth, impunctate and shiny, otherwise moderately punctate. Mandibles bidentate at tips. Malar space at least one and one-half times as long as width at articulation at base of mandibles, distinctly punctate on lower or caudal half and smooth and shiny on upper half. Ocelli situated just above narrowest part of the vertex; area between ocelli and compound eyes with a few punctures near compound eyes; remainder of area smooth, polished and impunctate. Compound eyes normal. Flagellum about four times as long as the scape, with middle and distal segments somewhat arcuate; third and fourth flagellar segments about equal in length, the fifth at least one and one-half times as long



as the third. Outer or upper apical angles of metatarsi of hind and middle legs with a strongly produced angular projection; upper edge of hind metatarsus arcuate and with hairs near base scarcely longer than those on middle or distal part of edge, about four times as long as greatest width.

Genitalia (figure 1) with head of each sagitta (figure 4) with jagged teeth on lower margin extending back from tip for about one-fourth of the length of the sagitta, no sickle-like hook present, middle of each sagitta on lower margin with an angular downward projecting tooth. Volsellae projecting much beyond squamae and curved inward, a small recurved hook on upper distal end. Squama large, with a prominent hooked projection at base on mesal margin, beneath which extending downward as a continuation is another inward extending arm which ends in a large sharp prong. Uncus narrow, slightly widened at base. Outer spatha (figure 2) and inner spatha (figure 3) as in figures.

*Female*.—Labrum with tubercle-like areas deeply and widely separated, strongly punctate; lamella prominent and extending most of width of labrum. Mandibles (nomenclature of KRÜGER, 1920) without a conspicuous incisura lateralis; with teeth I and II, the gerader rand, a distinct sulcus obliquus, a basalfurche, a hauptleiste, a nebenleiste, a nebenfurche and a begleitfurche. Clypeus swollen, with large mesal anterior portion smooth, polished and but faintly punctured; latero-anterior corners somewhat depressed and strongly punctate. Malar space somewhat longer than its width at articulation of mandibles, with lower or caudal half with small punctures. Ocelli situated slightly above narrowest part of the vertex. Compound eyes normal. Antennae with the flagellum about twice as long as the scape; the third flagellar segment noticeably longer than the fifth, the fifth is longer than the fourth. Apical or outer upper angles of metatarsi of hind and middle legs with a strongly produced angular projection; upper edge of hind metatarsus somewhat arcuate, outer surface slightly concave, about three times as long as greatest width.

Sting sheath between two basal arms (genital guides of FRANKLIN) with a narrow, heavily chitinized strip along side margins, without conspicuous inner projections and no heavily chitinized detached areas in membrane (*incrustationes vestibuli aculei* of CHOLODKOVSKY) between these strips.

Besides the type of this new subgenus (*B. senex* VOLLENHOVEN), the species *B. irisanensis* (COCKERELL) from the Philippine Islands belongs here. *B. irisanensis* was formerly considered by the writer (1928) to belong to the subgenus *Hortobombus* VOGT, but a recent study of both *senex* and *irisanensis* in comparison with typical species of *Hortobombus* reveals that they should be placed in a new subgenus.

### **Rufipedibombus** SKORIKOV, 1922.

(Type *B. rufipes*, LEPELETIER, 1836, monobasic and by absolute tautonymy).

*Male*.—Labrum with small areas near each lateral margin smooth, impunctate and shiny, otherwise sparsely punctate and particularly so on anterior



depressed portion. Mandibles bidentate at tips. Malar space about one and one-third times as long as greatest width at articulation of mandibles, smooth and shiny, and lower or caudal portion with minute indistinct punctures. Ocelli situated just above the narrowest part of the vertex; area between ocelli and compound eyes with a few fine punctures near compound eyes; remainder of area smooth, polished and impunctate. Compound eyes normal. Flagellum about four times as long as the scape, middle and distal flagellar segments not arcuate; third and fourth segments about equal in length, fifth about one and one-fourth times as long as third. Outer or upper apical angles of metatarsi of hind and middle legs without a strongly produced angular projection; upper edge of hind metatarsus arcuate and with hairs near base two or three times longer than those on middle or distal part of edge, outer surface concave, about four times as long as greatest width.

Genitalia (figure 5) with head of each sagitta enlarged at middle on lower margin but without a distinct angular downward projecting tooth; head (figure 8) with a very broad inward directed sickle-like hook. Volsellae finger-like and projecting forward and inward far beyond squamae. Squama much reduced and visible from above mainly as an inward projecting arm. Uncus linear, as narrow at base where it unites with sagittae as at apex. Outer spatha (figure 6) and inner spatha (figure 7) as in figures.

*Female*.—Labrum with a deep, wide depression between tubercle-like areas; lamella prominent, but extending in middle of sclerite only about one-third the width of the labrum. Mandibles with a conspicuous incisura lateralis; with teeth I and II, the gerader rand, an indistinct sulcus obliquus, a basal-furche, a hauptleiste, a nebenleiste, a nebenfurche, and a begleitfurche. Clypeus but slightly swollen, with large mesal anterior portion smooth, polished and mostly impunctate; latero-anterior corners somewhat depressed and with large punctures. Malar space but slightly longer than its width at articulation of mandibles, smooth and shining. Ocelli situated in the narrowest part of the vertex. Compound eyes normal. Antennae with the flagellum about twice as long as the scape; the third flagellar segment about one and one-half times as long as the fourth, the fifth slightly longer than the fourth. Apical or outer upper angles of metatarsi of hind and middle legs without a pronounced angular projection; upper edge of hind metatarsus but slightly arcuate, outer surface slightly concave, about three times as long as greatest width.

Sting sheath between two basal arms with a narrow, heavily chitinized strip along side margins and membrane between them somewhat chitinized near where they join.

Besides the type of this subgenus (*B. rufipes* LEPELETIER), several species on the Asiatic mainland such as *B. eximius* SMITH belong here.

#### Other Subgenera.

*B. folsomi* FRISON and *B. melanopoda* (COCKERELL) cannot be definitely placed to subgenera at the present time owing to the fact that both are known



only from the unique female types. The fact that the metatarsus of the middle leg of *B. folsomi* is without a spine-like projection at apical outer angle indicates that this species belongs to the Section *Anodontobombus* KRÜGER. It cannot at present be definitely placed to subgenus until the male is discovered.

*B. melanopoda*, according to O. W. RICHARDS, has a pronounced spine-like or angular projection at apical outer angle of metatarsus of middle leg. This places this species in the Section *Odontobombus* KRÜGER. It cannot at present be definitely placed to subgenus until the male is discovered.

### C. NEW VARIETIES.

***Bremus (Rufipedibombus) rufipes* var. *richardsi* FRISON**, new variety.

*Queen*. — Structurally identical with the queen of *rufipes* (LEPELETIER) as described in this paper. Differs from the typical form of *rufipes* in having the scutellum entirely covered with light chocolate brown pubescence sharply contrasting with the black pubescence on remainder of the thorax.

*Holotype*. — Queen, 10,000 ft., May, 1914, Korinchi Peak, Sumatra.

Bears, also, a label as follows: "1915 - 182". Deposited in the collection of the British Museum of Natural History, London, England.

It is with great pleasure that I name this handsome bumblebee in honor of Mr. O. W. RICHARDS, of England, in recognition of his many kindnesses to the writer. This form had been previously recognized as new by the late G. MEADE-WALDO, but no description of it was ever published.

***Bremus (Senexibombus) senex* var. *pallidithorax* FRISON**, new variety.

*Male*. — Clypeus, front of head both below and above articulation of antennae, occiput and occipital orbits with long black pubescence; a small impunctate polished concave circular area on mesal anterior portion near clypeal-labral suture. Labrum with small areas near each lateral margin smooth, impunctate and shiny, otherwise moderately punctate; with short golden brown hairs. Mandibles with golden brown hairs, those fringing lower edge rather long; bidentate at tips. Malar space at least one and one-half times as long as its width at articulation of mandibles; distinctly punctate on lower or caudal half, mostly smooth and shining on upper half; about two-thirds as long as the greatest width of, and about one-third as long as, the compound eye. Ocelli situated just above narrowest part of the vertex; each lateral ocellus closer to the median ocellus than its diameter; area between ocelli and median margin of compound eyes with a few punctures near compound eyes, the remainder of this area smooth, polished and impunctate. Flagellum about four times as long as scape; third flagellar segment slightly longer than the fourth, fifth at least one and one-half times as long as the third; middle and distal flagellar segments somewhat arcuate.



Dorsum of the thorax with center or disk, except smooth, polished impunctate area, with whitish or hoary pubescence; remainder of dorsum and pleurae with long black pubescence.

Abdomen with the first four dorsal segments entirely covered with long black pubescence; fifth dorsal segment mainly black, but with some golden-brown or ferruginous pubescence on posterior margin; sixth dorsal segment similar to the fifth, except ferruginous pubescence dominates; seventh dorsal segment almost entirely with ferruginous pubescence. Venter with mostly dark pubescence, except that on posterior margin of seventh it is ferruginous. Hypopygium with posterior margin strongly ridged, the part anterior to ridge smooth, polished and with few punctures.

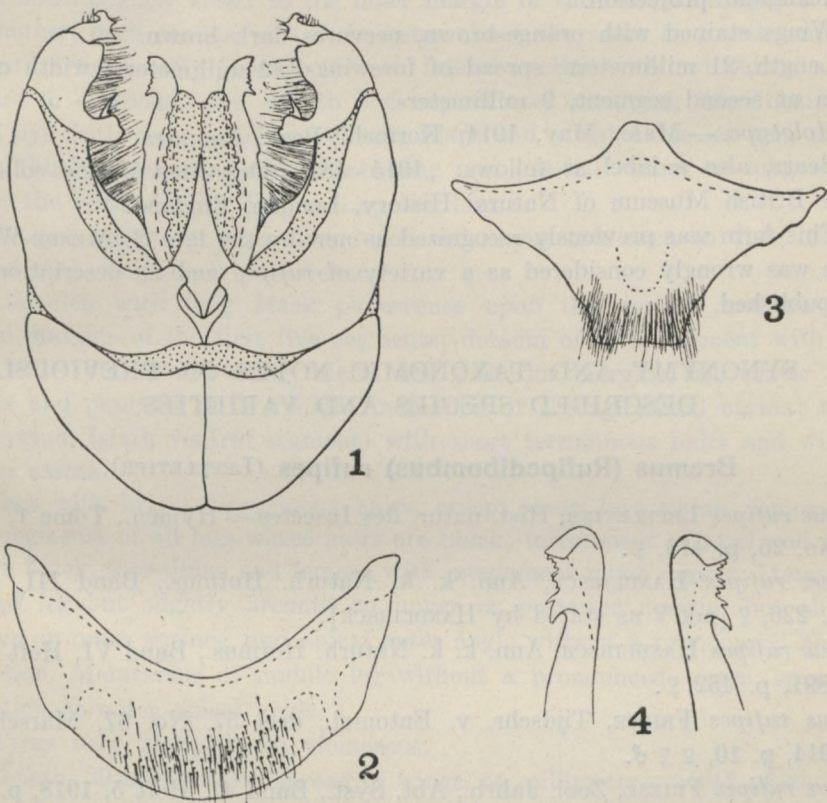


Fig. 1-4.—*Bremus senex* var. *pallidithorax* FRISON.  
1. Dorsal view of male genitalia; 2. Outer spatha of male; 3. Inner spatha of male; 4. Heads of sagittae of male.—All enlarged.

Genitalia (figure 1). Head of each sagitta (figure 4) with jagged teeth on lower margin extending back from the tip for about one-fourth of the length of the sagitta, no sickle-like hook present; middle of each sagitta on lower margin with an angular downward projecting tooth. Volsella projecting much beyond squama and curved inward; a small recurved hook on upper distal end.



Squama large, with a prominent hooked projection at base on mesal margin, beneath which extending downward as a continuation is a projection on lower mesal margin which at tip ends in a large sharp prong. Uncus narrow, slightly widened at base. Outer spatha (figure 2) and inner spatha (figure 3) as in figures.

Legs with integument of tarsi and tibiae reddish, that of femora black. Hairs on tarsi and tibiae golden-brown, those on femora black. Metatarsus of hind leg arcuate on upper edge and with hairs near base scarcely longer than those on middle or distal part of edge, outer surface concave, upper posterior angle acute or strongly produced; about four times as long as greatest width. Outer or upper apical angle of metatarsus of middle leg with a strongly produced angular projection.

Wings stained with orange-brown, nervures dark brown.

Length, 21 millimeters; spread of forewings, 42 millimeters; width of abdomen at second segment, 9 millimeters.

*Holotype*. — Male, May, 1914, Korinchi Peak, Sumatra.

Bears, also a label as follows: „1915 - 182". Deposited in the collection of the British Museum of Natural History, London, England.

This form was previously recognized as new by the late G. MEADE-WALDO, but it was wrongly considered as a variety of *rufipes* and no description was ever published.

#### D. SYNONYMY AND TAXONOMIC NOTES ON PREVIOUSLY DESCRIBED SPECIES AND VARIETIES.

##### ***Bremus (Rufipedibombus) rufipes* (LEPELETIER).**

*Bombus rufipes* LEPELETIER, Hist. natur. des Insectes — Hymén., Tome 1, 1836, No. 25, p. 473, ♀.

*Bombus rufipes* HANDLIRSCH, Ann. k. k. Naturh. Hofmus., Band III, 1888, p. 226, ♀ [not ♀ as stated by HANDLIRSCH].

*Bombus rufipes* HANDLIRSCH, Ann. k. k. Naturh. Hofmus., Band VI, Heft 3 - 4, 1891, p. 452, ♀.

*Bombus rufipes* FRIESE, Tijdschr. v. Entomol., deel 57, No. 67, Marsch 21, 1914, p. 10, ♀ ♀ ♂.

*Bombus rufipes* FRIESE, Zool. Jahrb., Abt. Syst., Band 41, Heft 5, 1918, p. 517, ♀ ♀ ♂.

*Bombus (Rufipedibombus) rufipes* SKORIKOV, Bull. Stat. Regionale Protect. Plantes, Petrograd, Vol. IV, Part 1, November, 1922, p. 123 and p. 156. Type of *Rufipedibombus* SKORIKOV (autobasic).

*Queen*. — Face, occipital orbits and occiput with black hairs. Labrum with a deep, wide, punctate depression between tubercle-like areas; each tubercle-like area with mesal and upper margin strongly punctate and ridged, remainder of area, gradually rounded off towards sides and base; shelf-like projection



(lamella) prominent, but extending only about one-third the width of labrum. Mandibles with two small teeth on upper mesal margin and a third on lower mesal margin, between these teeth is a smooth and wide even-edged surface; base of mandibles with numerous large and small punctures; setae on distal portion between polished carinae short, dense and of a golden-brown color, a few long hairs on lower proximal portion. Disk of clypeus smooth and shining, with a few large widely separated punctures; anterior-lateral corners somewhat depressed and with large punctures otherwise smooth and shining. Malar space but slightly longer than its width at articulation of mandibles, smooth and shining; about three-fourths as long as greatest width of and about one-fourth length of compound eye. Ocelli situated in the narrowest part of the vertex, lateral ocelli slightly closer to the inner margin of the compound eyes than to one another, each ocellus with a diameter about the same as fourth antennal segment; area directly laterad of each lateral ocellus with two-thirds of the distance to compound eye smooth and impunctate, remaining third near compound eye with some small punctures. Flagellum about twice as long as the scape; third antennal segment about one and one-half times as long as the fourth, the fifth slightly longer than the fourth.

Thorax, except for smooth and polished impunctate area on disk, entirely covered with long black pubescence.

Abdomen with long black pubescence upon the dorsum and posterior ventral margins of the first five segments; dorsum of sixth segment with very short black pubescence along lateral and posterior margins, the center being shining and punctate with a slight indication of a longitudinal carina; tip of hypopygium (sixth ventral segment) with short ferruginous hairs and without median carina.

Legs with bright ferruginous hairs, except upon fore tibiae, femora and basal segments of all legs where hairs are black; integument of tarsi and tibiae reddish black, fore-tibiae and femora with integument much darker. Metatarsus of hind leg but slightly arcuate on upper or posterior margin, but slightly concave on outer surface, and apical outer angle without a pronounced angular projection. Metatarsus of middle leg without a pronounced, sharp, spine-like projection at outer apical angle.

Wings very dark, almost violaceous.

Length, 29 millimeters; spread of wings, 54 millimeters; width of abdomen at second segment, 16 millimeters.

*Worker*.—Structurally and in color similar to the queen as redescribed above. Differs in being smaller in size.

*Male*.—Clypeus densely covered with long black pubescence, except for a small, narrow, smooth and polished mesal area on the anterior portion near clypeal-labral suture. Pubescence on occipital orbits, surrounding bases of antennae and occiput entirely black. Malar space about one and one-third times as long as greatest width at articulation of mandibles, about two-thirds as long as greatest width of and a little less than one-fourth as long as length of com-



pound eye; smooth and shiny. Ocelli of moderate size, situated just above the narrowest part of the vertex, each lateral ocellus removed less than its diameter from median ocellus and about twice its diameter from inner margin of compound eye. Space between each lateral ocellus and compound eyes smooth and shiny, a few fine punctures near compound eyes. Labrum with two large, smooth, polished, impunctate slightly raised areas on each side of meson. Mandibles densely hairy, bidentate at tips. Flagellum about four times as long as scape; third and fourth segments about equal in length, fifth about one and one-fourth times as long as the fourth, middle flagellar segments not distinctly arcuate.

Entire thorax covered with uneven black pubescence. A smooth, polished impunctate area on disk of mesonotum and a similar narrow linear area on disk on scutellum.

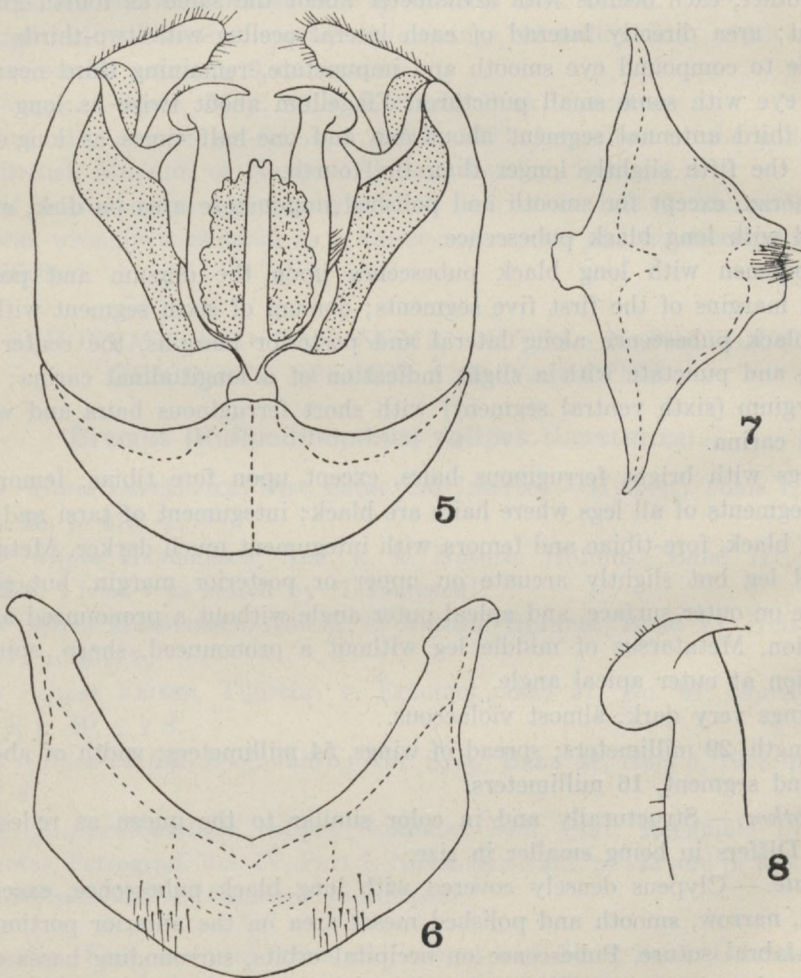


Fig. 5-8. — *Bremus rufipes* LEPELETIER.  
5. Dorsal view of male genitalia; 6. Outer spatha of male; 7. Inner spatha of male; 8. Heads of sagittae of male. — All enlarged.



Abdomen entirely covered with black pubescence, except for apical fringe of hairs on hypopygium which are golden-brown. Hypopygium with edges sharply ridged on the sides as well as at end, the enclosed area being smooth, polished and but slightly punctate.

Genitalia (figure 5). Each sagitta enlarged at middle on lower margin but without a distinct angular downward projecting tooth; head (figure 8) with a very broad sickle-like inward directed hook. Volsella finger-like and projecting forward and inwardly far beyond squamae. Squama much reduced and visible from above mainly as an inwardly projecting arm. Uncus linear, as narrow at base where it unites with sagittae as at apex. Outer spatha (figure 6) and inner spatha (figure 7) as in figures.

Legs with integument of tibiae and tarsi an obscure reddish black, that of femora entirely black. Hairs black. Metatarsus of hind leg arcuate on upper edge and with hairs near base two or three times longer than those on middle or distal part of edge; outer surface concave; upper apical angle not sharply produced; about four times as long as greatest width. Metatarsus of middle leg at apical outer angle without a pronounced projection.

Wings very dark, almost with violaceous reflections.

Length, 20 millimeters; spread of wings, 40 millimeters; width of abdomen at second segment, 9 millimeters.

According to Dr. L. BERLAND the type of this species is not in the collection of the Musée Nationale at Paris, France, and I cannot discover its whereabouts if it is still in existence. Therefore, I am selecting a male of this species from Korinchi Peak, Sumatra, May, 1914, as the *Neotype* and depositing it in my private collection of these social bees.

The original description by LEPELETIER (1836) of this large and handsome bumblebee is as follows:

„*Hirsutus, niger, tarsi omnibus tibisque duobus posticis rufis, rufoque hirtis; alis violaceis.*”

„Noir. Tous les tarses foncièrement roux, ainsi que les deux jambes postérieures; les poils de ces parties roux en dessus et en dessous. Ailes rembrunies, avec un reflet violet.

„*Ouvrière* probablement. Long. 6 lig.

„Ile de Java, d'après M. LATREILLE. Musée de M. le comte DEJEAN.”

Additional notes regarding the structural characters of the worker are given by HANDLIRSCH (1888). FRIESE (1914 and 1918) has recorded additional specimens and SKORIKOV (1922) has erected a new subgenus — *Rufipedibombus* — for the reception of this species.

This beautiful bumblebee has been recorded from the mountainous regions of both Sumatra (Mt. Singalang) and Java. I have studied specimens of all castes loaned by the British Museum from Sumatra (Korinchi Peak) and a queen without locality label determined as this form by FRIESE. SKORIKOV (1922, p. 156) lists the range of this species as India, Java, Sumatra, and the Philippines but I know of no authentic records of this species from the Philippine Islands



(FRISON, 1928) or India. The subgenus *Rufipedibombus* is, however, not confined to the East Indies and is represented in India, China and Formosa (for example, *eximius* SMITH and varieties). Since SKORIKOV (1922, p. 159) lists *eximius* and *latissimus* as „Bombi incertae sedis” it is evident that he was not aware of the generic relationship of these forms and considering them as varieties of *rufipes*. In view of the distribution of *Rufipedibombus* in India, China, Formosa, Sumatra and Java it will be surprising if a member of this subgenus is not eventually found both in Borneo and the Philippine Islands.

*B. rufipes* LEP. from Sumatra and Java may be separated from *eximius* SMITH by the difference in color of the wings. In *rufipes* the wings are very dark, almost with violaceous reflections, whereas in *eximius* and varieties the wings are mostly a yellowish-brown with at most the apical portions darker. According to information in a letter from Mr. RICHARDS, *B. festivus* SMITH from northern India is a *Rufipedibombus*.

***Bremus (Rufipedibombus) rufipes* var. *flavipes* (HANDLIRSCH).**

*Bombus flavipes* HANDLIRSCH, Ann. k. k. Naturh. Hofmus., Band III, 1888, p. 225, ♀.

*Bombus rufipes* var. *flavipes* HANDLIRSCH, Ann. k. k. Naturh. Hofmus., Band VI, Heft 3 - 4, 1891, p. 452, ♀ ♀ ♂.

*Bombus rufipes* var. *flavipes* FRIESE, Tijdschr. v. Entomol., deel 57, No. 67, March 21, 1914, p. 10. [record of HANDLIRSCH, 1891].

*Bombus rufipes* var. *flavipes* FRIESE, Zool. Jahrb., Abt. Syst., Band 41, Heft 5, 1918, p. 517 - 518, ♀ ♀.

*Queen*.—Structurally similar to the queen of *rufipes* LEPELETIER as redescribed in this paper. Differs in having the last two or three apical dorsal abdominal segments with ferruginous pubescence.

*Worker*.—Similar to the queen but smaller.

*Male*.—Structurally similar to the male of *rufipes* LEPELETIER as redescribed in this paper. Differs in having the last two or three apical dorsal abdominal segments with ferruginous pubescence.

The type of *B. flavipes* (HANDLIRSCH) is now in the private collection of Dr. A. v. SCHULTHESS, Zürich, Switzerland. He writes that later it will be deposited in the collection of the Entomological Institute of the Swiss Polytechnic School at Zürich, Switzerland.

The original description of this "red-tailed" color variety of *rufipes* LEP. is as follows:

„25 mm. Kopf, Thorax und Hinterleib mit Ausnahme der beiden roth behaarten Endsegmente mit langer schwarzer Behaarung bedeckt. Flügel dunkel schwarzbraun, stark violett schimmernd. Vorder-, Mittel- und Basis der Hinterbeine rothbraun, Schienen und Tarsen der Hinterbeine röthlichgelb. Die Hinterseite der Hinterschienen und die Hintertarsen sind mit anliegender, feiner, gelber Behaarung bedeckt, im Uebrigen ist die Behaarung der Beine schwarz.

„Der Kopf ist gross und breit; Wangen so lang als am Ende breit; Clipeus



stark gewölbt, glänzend, in der Mitte sehr spärlich, an den Rändern dichter punktiert; Oberlippe in der Mitte mit einer tiefen Grube versehen; Mandibeln stark gefurcht, am Endrande nur sehr schwach gezähnt. Das 3. Fühlerglied ist kaum um die Hälfte länger als das 4., dieses sehr wenig kürzer als das 5. — Metatarsus der Hinterbeine am Ende nicht in eine Spitze ausgezogen.

„Sechste Bauchplatte ohne Kiel, die entsprechende Rückenplatte mit sehr grober Sculptur.“

In 1891, HANDLIRSCH recorded all castes of this color variety from East Java, gave a fairly detailed description of the structural characters of the female, and figured a rough sketch of the male genitalia which is identical with that of the typic form. At the same time he called attention to the specific agreement of *rufipes* and *flavipes* and relegated the latter to its proper status as a color variety of the former. The references in literature since then by FRIESE (1914 and 1918) have repeated records of HANDLIRSCH (1891) and added new ones.

This color variety of *rufipes* has been recorded previously only from the East Indies and East Java by HANDLIRSCH (1888 and 1891). I have studied a queen from Buitenzorg, Java (SCHMIEDK.) determined as this variety by FRIESE and loaned to me by the American Museum of Natural History, and one queen (Tengger Geb., Ost-Java) and one worker (Java, 1891, FRUHSTORFER) loaned to me by Dr. MAIDL of the Hofmuseum, Wien, Austria, determined by HANDLIRSCH as this variety and undoubtedly part of the material recorded by him in 1891.

***Bremus (Rufipedibombus) rufipes* var. *obscuripes* (FRIESE).**

*Bombus rufipes* var. *obscuripes* FRIESE, Tijdschr. v. Entomol., deel 57, No. 67, March 21, 1914, p. 10, ♀ ♀ ♂.

*Bombus rufipes* var. *obscuripes* FRIESE, Zool. Jahrb., Abt. Syst., Band 41, Heft 5, 1918, p. 517-518, ♀ ♀ ♂.

*Queen*. — Structurally similar to the queen of *rufipes* LEPELETIER as redescribed in this paper. Differs in having the hairs on the legs entirely black.

*Worker*. — Similar to the queen but smaller.

*Male*. — Structurally similar to the male *rufipes* LEPELETIER as redescribed in this paper. Differs in having the hairs on the legs entirely black.

The typic specimens of this variety are now in the possession of Dr. H. FRIESE, Schwerin, Germany. He informs me that later they will be deposited in the Berlin Museum, Germany.

The original description of this color variety of *rufipes* LEP. was given by FRIESE as „wie *B. rufipes* aber alle Beine wohl rotgefärbt, doch mit schwarzer Behaarung“.

FRIESE (1914 and 1918) records this variety from Java (Gunung Papan-dajan, Bandung, Salatiga, Gunung Gedeh, Soekaboemi and Tjibodas). I have studied females of this variety determined by FRIESE from Tjibodas and Ban-



dung (probably of paratype status) which were loaned to me by the American Museum of Natural History.

Additional material from Java has been loaned to me by the Zoological Museum, Buitenzorg, Java, as follows: 1 ♀ Mount Salak, December, 1900; 9 ♀ and 1 ♀, Tjibodas, slope of Mount Gedeh, 1400 m. above sea level, 4 ♀ and 1 ♀ on August, 1921, and 1 ♀ and 1 ♀ on January, 1900; 2 ♀, 2 ♀ and 1 ♂, Pengalengan, April 1920; 2 ♀, 15 ♀ and 3 ♂, Mount Slamet, February, 1917; 1 ♀, 2 ♀ and 7 ♂, Bandjar; 2 ♀ Tjitjoeroek-Salak (between Tjitjoeroek and Mount Salak), about 700 m. above sea level, March 6, 1921, collected by H. H. KARNY, and 1 ♀ on January 1, 1921; 1 ♀ and 1 ♂, Buitenzorg, February, 1920; and 1 ♀ from Preanger. In addition I have studied two workers of this variety without locality labels and determined as *rufipes* by HANDLIRSCH. These were sent to me by Dr. MAIDL of the Hofmuseum, Wien, Austria, and are undoubtedly part of the material recorded by HANDLIRSCH in 1888. These latter specimens indicate that the HANDLIRSCH records of 1888 refer both to the typical *rufipes* and its variety *obscuripes*.

***Bremus (Rufipedibombus) rufipes* var. *intermissus* (FRIESE).**

*Bombus rufipes* var. *intermissus* FRIESE, Zool. Jahrb., Abt. Syst., Band 41, Heft 5, 1918, p. 516, ♀ ♀.

*Queen*.—Structurally similar to the queen of *rufipes* LEPELETIER as redescribed in this paper. Differs in having the corbicular fringes on the basal half of the hind tibiae black and those on the apical half reddish.

*Worker*.—Similar to the queen but smaller.

The type specimens of this variety are now in the possession of Dr. HEINRICH FRIESE, Schwerin, Germany. He informs me that later they will be deposited in the Berlin Museum, Germany.

The original description of this color variety of *rufipes* LEPELETIER is as follows:

„Wie *B. rufipes* LEPELETIER, aber die Körbchenhaare an der Basalhälfte der Tibia III schwarz. Länge ♀ 28 mm, Breite 15 mm; Länge ♂ 14 - 18 mm, Breite 7 - 8 mm.

„Die Form *intermissus* steht also zwischen *rufipes* und *obscuripes* FR., sie vermittelt den Uebergang zwischen beiden, und da die Körbchenbehaarung oft mehr oder weniger schwarz ist, so zeigen die einzelnen Exemplare das Werden des *obscuripes* sehr deutlich.

„Zentral-Sumatra, bei Beras Tagi (♂), im Mai gefangen und auf Java, bei Tjibodas (♀ ♀) im März.”

No additional records have been published for this color variety since its original description. I have studied a worker of this variety (probably a paratype) from Beras Tagi (Bfastagi), North Sumatra, determined as this variety by FRIESE and loaned to me by the American Museum of Natural History.



**Bremus (Senexibombus) senex** (VOLLENHOVEN).

*Bombus senex* VOLLENHOVEN, Tijdschr. v. Entomol., jaargang 16, 1873, p. 229, pl. 10, col. fig. A and B, ♀.

*Bombus rufipes* var. *senex* RITSEMA, Notes Leyden Museum, VI, 1884, p. 200, ♀.

*Bombus senex* HANDLIRSCH, Ann. k. k. Naturh. Hofmus., Band III, 1888, p. 227, ♀.

*Bombus eximius* var. *senex* FRIESE, Tijdschr. v. Entomol., deel 57, No. 67, March 21, 1914, p. 11, ♀.

*Bombus senex* FRIESE, Zool. Jahrb., Abt. Syst., Band 41, Heft 5, 1918, pp. 516-517, ♀.

Female (♀) type in good condition in the collection of the Rijks Museum voor Natuurlijke Historie, Leiden, Holland.

*Queen*. — Face, occipital orbits and occiput with black hairs. Labrum with tubercle-like areas deeply and widely separated, with numerous coarse punctures, slightly shagreened; lamella prominent and extending most of width of labrum. Mandibles without conspicuous incisura lateralis; with teeth I and II, the gerader rand, a distinct sulcus obliquus, a basalfurche, a hauptleiste, a nebenleiste, a nebenfurche, and a begleitfurche. Disk of clypeus smooth and shiny with a few small scattered punctures, anterior-lateral corners depressed and strongly punctate, middle anterior portion of clypeus with a circular concavity. Malar space about one and one-half times as long as width at articulation of mandibles, smooth and shining, with lower or caudal half with small punctures. Ocelli situated just above narrowest part of the vertex, lateral ocelli as close to inner margin of compound eyes as to one another, each ocellus with a diameter about equal to width of fourth antennal segment; area directly laterad of each lateral ocellus smooth and shiny, with but few punctures near compound eye, immediately caudad of smooth area is a densely punctate area. Flagellum about twice as long as the scape; third antennal segment noticeably longer than the fifth, the fifth longer than the fourth, segments not arcuate.

Thorax, except for smooth and polished area on disk, entirely covered with long whitish pubescence.

Abdomen with long whitish pubescence on the first four dorsal segments; dorsum of fifth segment with whitish pubescence tinged with orange; dorsum of sixth segment with very short black and orange pubescence along lateral and posterior margins, the center being shining and with scattered punctures; tip of hypopygium (sixth ventral segment) without a median keel or carina. Venter of abdomen with black pubescence.

Sting sheath between basal arms with a narrow heavily chitinized strip along side margins, without conspicuous inner projections and no heavily chitinized detached areas in membrane between strips.

Legs with all tarsi and usually corbicular fringes with bright ferruginous or golden hairs, remainder of legs with hairs mostly black; integument of hind tarsi and tibiae reddish, darker on other segments. Apical or outer upper angles



of metatarsi of hind and middle legs with a strongly produced angular projection; upper edge of hind metatarsus somewhat arcuate, outer surface slightly concave, about three times as long as greatest width.

Wings distinctly stained with orange-brown, the nervures darker.

Length, 24 millimeters; spread of wings, 48 millimeters; width of abdomen at second segment, 12 millimeters.

*Worker*. — Specimens with pubescence colored like the queen are not as yet known. See notes under varieties *ardentior* (CKLL.) and *sumatrensis* (CKLL.).

*Male*. — No males belonging to the species *senex* with the pubescence colored like the queens have thus far been found. It may be that the males exhibit dimorphism and normally assume the colors of varieties *ardentior* (CKLL.) or *pallidithorax* FRISON. If males of *senex* are later found with colors comparable to the typical queens, their structural characters will be the same as described under *pallidithorax* FRISON.

The original description of this species is as follows:

„Cette nouvelle espèce se distingue de toutes les autres qui me sont connues par la blancheur de son poil et la limpidité de ses ailes.

„La couleur générale du corps est noire. La tête est assez grosse par rapport à la taille de l'insecte, faiblement ponctuée, à chaperon très-lisse et bombé. Le front et l'occiput sont couverts de poils bruns et blancs entremêlés, ceux de la face et des joues sont tous bruns. Les yeux sont grands, en ovale allongé de couleur gris-brune; les ocelles sont petits et jaunâtres. Les antennes, médiocrement longues, sont noires, d'un ton mat. Les mandibules sont noires, luisantes; les autres parties de la bouche d'un brun de poix.

„Le thorax est couvert sur la partie dorsale et le long des flancs du mésothorax de longs poils d'un blanc argenté qui lui forment une belle fourrure de grande densité; les autres parties sont couvertes de quelques poils soyeux d'un noir brunâtre, entre lesquels on distingue aisément que la poitrine est peu ponctuée. Les pattes sont d'un rouge jaunâtre et couvertes d'assez longs poils noirs, excepté sur les tarses et sur les deux faces plates des jambes postérieures, ainsi que sur la corbeille tant en dessus qu'en dessous. Les ailes sont transparentes d'un blanc jaunâtre à nervures d'un rouge brunâtre, la costale plus foncée; leurs épaulettes sont de même d'un blanc plus ou moins jaune.

„Le dos de l'abdomen est couvert de poils argentés semblables à ceux du thorax; le ventre, dont la couleur est un noir brun et qui est densément ponctué, n'est fourni que de peu de poils d'un noir grisâtre, plus soyeux que ceux du dos. L'aiguillon d'un brun de poix est recourbé en haut.

„Cette belle espèce habite l'île de Sumatra; M. le Docteur LUDEKING fit cadeau au Museum royal d'histoire naturelle de la femelle qui a servi à cette description.”

This species is known only from Sumatra. FRIESE (1918) summarizes the records of this species since the original description as follows: „bei Tau am Vulkan Dempo an Geisblatt (*Lonicera*) im Jahre 1884 und auch an *Melastoma*-Arten in 2300 m. Höhe” and „von Sumatra (Bergregion)”. I have studied in detail



two queens loaned to me by the British Museum with data as follows: 1 queen, May, 1914, 10,000 ft., Korinchi Peak, Sumatra, and 1 queen, April 1914, 5,000 ft., Sungei Kring, Sumatra. A third queen, graciously donated to me by the Rijks Museum voor Natuurlijke Historie, Leiden, Holland, bears the data „Gun. Teleman, Sumatra, June, 1917, coll. Edw. JACOBSON". I am informed that other specimens are in the collection of the Rijks Museum.

***Bremus* (*Senexibombus*) *senex* var. *sumatrensis* (COCKERELL).**

*Bombus sumatrensis* COCKERELL, Ann. Mag. Nat. Hist., 7th Series, Vol. 16, 1905, p. 392, ♀ (not ♀ as stated in original description).

I have seen no specimens of this variety and none have been recorded in literature since the original description based upon the unique type. This type certainly belongs to the worker caste instead of being a queen. In the re-description of *senex* (VOLLENHOVEN), I have noted the circular depression on the median anterior portion of the clypeus. Mr. O. W. RICHARDS has very kindly examined the type of *sumatrensis* (COCKERELL) in the British Museum and reports that the clypeus has the same "curious circular depression" on the clypeus as *senex*. In view of the limited bumblebee fauna of the East Indies and the absence of a difference in structural characters between *senex* and *sumatrensis*, it seems advisable to the writer to consider the latter as a color variety of the former.

*Worker*.—Structurally similar, except for smaller size, to the queen of *senex* as redescribed in this paper. Differs from *senex* as follows: first two dorsal abdominal segments mostly with black pubescence; that on lateral margins, especially on second segment, yellowish white; third dorsal segment with black pubescence; fourth and fifth segments yellowish-white.

*Worker* (♀) type in the collection of the British Museum.

The original description of this variety is as follows:

"*Queen*.—Length about 18 mm.

"Head elongata, narrow, the greater part of the clypeus, which is smooth and shining, below the level of the eyes; malar space long, smooth and shining; a round red tubercle at extreme base of mandibles; labrum bituberculate, with a median depression, its lower part with reddish and black hair; hair of face and cheeks long and black, that of upper part of head mixed black and white, the white hairs being long and mainly on the occiput; antennae entirely black, scape long, strongly curved; first joint of flagellum as long as third or slightly longer, the second much shorter than either; hair of thorax long, dense, yellowish white, with no sign of any median band or patch. Legs very dark reddish, the hind tibiae and tarsi quite bright ferruginous; hair of legs black and orange, the latter mainly on the distal parts; hind metatarsi very broad. Wings strongly suffused with orange-brown, nervures ferruginous. Hair of abdomen long, black on first two segments, with yellowish white towards the sides, especially on the second; black on third segment, yellowish white on fourth and fifth, the



colours largely mixed owing to the overlapping of the long hairs and the presence of more or less pale hair even amongst the black; hair of venter black, except at apex (principally fringe of penultimate segment), where it is yellowish.

"*Hab.* Sumatra; marked "at flower, 2381. X<sup>2</sup>, 2.5.81". In the collection of British Museum, received in 1892."

This color variety, like the species to which it belongs, is known to date only from Sumatra. It, or *senex* var. *ardentior* (COCKERELL), may prove to be the normal form of the worker of *senex*. Such color dimorphism is of rather common occurrence among bumblebees.

***Bremus (Senexibombus) senex* var. *ardentior* (COCKERELL).**

*Bombus sumatrensis* var. *ardentior* COCKERELL, Ann. Mag. Nat. Hist., 8th Series, Vol. 5, 1910, p. 416, ♀ (not ♀ as stated in original description).

One worker and one male of this color variety of *senex* (VOLLENHOVEN), belonging to the British Museum, have been studied. The worker bears the label "Sumatra, X/2/5/81, 92.182" suggestive of the same general lot of material as the type. As in the case of *senex* and its other color variety *sumatrensis* (COCKERELL), this variety has the circular depression on the median anterior portion of the clypeus; a structural character proving its affinity with them. This relationship is further substantiated by the study of a worker which was kindly donated to me by the Rijks Museum voor Natuurlijke Historie. This latter worker bears the following data on the pin label: Gun. Teleman, Sumatra, June, 1917, Coll. EDW. JACOBSON.

*Worker*.—Structurally similar, except for smaller size, to the queen of *senex* as redescribed in this paper. Differs from *senex* as follows: first four dorsal abdominal segments mostly with black pubescence; at least some specimens with sides of thorax mostly with black pubescence; both fourth and fifth dorsal abdominal segments, or only the fifth, with dull ferruginous pubescence; wings slightly darker.

*Worker* (♀) type in the collection of the British Museum.

*Male*.—Structurally similar to the male *senex* var. *pallidithorax* as described in this paper. Differs in color as follows: Dorsum of thorax entirely covered with hoary or whitish pubescence, that on sides of thorax mixed with dark pubescence; dorsum of first two dorsal abdominal segments mostly covered with black pubescence, except posterior margins which are whitish; third and fourth dorsal abdominal segments mostly whitish but with some black pubescence intermixed, particularly on anterior margins; fifth, sixth and seventh dorsal abdominal segments with dull ferruginous pubescence.

*Allotypic Male*.—Barong Baru, Korinchi, Main Range, Sumatra, 4,000 feet elevation, June, 1914. Deposited in the collection of the British Museum.

The original description of this variety is as follows:

„Queen.—Length about 17 mm.

„Structure\*as in *B. sumatrensis*; hair of face, front, vertex, and cheeks entirely black; of labrum reddish black; of thorax above yellowish white; of



abdomen black, on fourth and fifth segments rather dull ferruginous. A colour-variety only, with the abdominal band red instead of yellowish white.

"Hab. Sumatra, "X.1, 5.81". British Museum, 92.182."

As suggested under *senex* var. *sumatrensis*, either this worker variety or *sumatrensis* may be the normal form of the worker of *senex*. Known to date only from the type and present recorded specimens. It is quite evident that the type is a worker instead of a queen as stated in the original description.

**Bremus** (subgenus?) **folsomi** FRISON.

*Bremus folsomi* FRISON, Trans. Amer. Ent. Soc., Vol. XLVIII, No. 835, March 2, 1923, p. 322, ♀.

No specimens of this sole known representative of the genus *Bremus* in Borneo have been recorded since the original description. The original description is as follows:

*Queen*.—Face, occiput and cheeks with brownish-black pile. Labrum moderately punctate; tubercle-like areas large, slightly shagreened, with the space between them equal to the length of the second flagellar segment; shelf-like projection broad; pile on anterior margin bright golden in color. Mandible distinctly four-toothed, the fourth tooth, however, much less developed than the others; setae on the distal portion between the longitudinal ridges very short, dense and bright golden in color, that on the lower proximal portion very long and of the same color as the short setae. Clypeus with numerous small punctures on the disk, and large scattered punctures mixed with smaller ones on the lateral, dorsal and anterior portions. Malar space slightly shorter than its width at articulation of mandibles, about two-thirds the greatest width of and one-fourth the length of the eye. Ocelli situated slightly above the narrowest part of the vertex; lateral ocelli almost as far distant from each other as from inner margin of eye; area between lateral ocelli and eyes polished, impunctate except for a very few small punctures near inner margin of eye. Flagellum about twice as long as the scape; third antennal segment somewhat longer than the fifth, the fifth slightly longer than the fourth.

"Entire dorsum and pleura of thorax, except for the small polished and impunctate disk, covered with moderately long tawny-yellow pile.

"Abdomen with the first dorsal segment yellow, the pile being short and sparse on the middle portion; second dorsal segment with dull ferruginous pile on the sides and yellow in the middle; third, fourth and fifth dorsal segments with dull ferruginous pile; sixth dorsal segment with short brownish-black pile. Venter with golden and brown pile fringing posterior margins of the segments. Hypopygium without a median carina.

"Legs black, but with the pile on the ventral surfaces of the femora and a portion of the tibiae dull golden or ferruginous. Corbicular fringes both on the dorsal and ventral margins bright ferruginous. Hind metatarsi distinctly arcuate.



"Wings pale brown, the nervures distinctly outlined in darker brown.

"Length, 20 mm; spread of wings, 39 mm; width of abdomen at second segment, 10 mm.

"*Holotype*. — Queen, Kina Balu, British North Borneo.

"The *holotype*, No. 10542, is in the collection of the Academy of Natural Sciences of Philadelphia."

The *holotype*, as stated in original description, is in the collection of the Academy of Natural Sciences, Philadelphia, Pennsylvania.

When the species was described no mention was made of the shape of the metatarsus of the middle leg. A recent study of the middle leg reveals that this species is without a spine-like projection at the apical outer angle of the metatarsus of the middle leg.

***Bremus* (subgenus!) *melanopoda* (COCKERELL).**

*Bombus rufipes* var. *melanopoda* COCKERELL, Ann. Mag. Nat. Hist., 8th Series, Vol. 5, 1910, p. 416, ♀.

I have seen no specimens of this species and none have been recorded since the original description based upon an unique female was published in 1910. Since the original description does not give sufficient information regarding the structural characters for the definite recognition of this species, Mr. O. W. RICHARDS has very kindly supplied the following notes concerning the characters of the typic female.

*Queen*. — Malar space about twice as long as broad at articulation with mandible, as long as the transverse diameter of the compound eye. Labrum with labral furrow shallow, narrow, about one-half as broad as tubercle; lamella nearly as broad as a tubercle. Clypeus a little swollen, apical depression scarcely marked, with close, medium sized punctures which are finer and fewer on the disk. Ocelli lying on the supraorbital line, each lateral ocellus being separated from the compound eye by about two and one-half times its width; a small space around the ocelli unpunctured. Third antennal segment as long as fourth and fifth together; fourth only a little longer than quadrate; fifth one and one-half times as long as broad.

Metatarsus of middle leg at apical outer angle with a pronounced spine-like projection. Upper apical angle of hind tibiae not produced.

Hypopygium apparently without a conspicuous median carina or keel.

Body covered with black pubescence; hind tibiae somewhat pitchy; wings subhyaline.

The female type labelled "Sumatra" is in the British Museum.

The original description of this species is as follows:

"*Queen*. — Length about 25 mm; anterior wing 18.

"Robust, black, with black pubescence, that on apex of labrum ferruginous; legs black, the hind tibiae very dark reddish. Wings dark.



"Similar to *B. rufipes*, but distinguished by the dark black-haired legs. The difference is not absolute, as the hind legs have many of the long tibial hairs orange-tipped and the hair on the inner side of the basitarsus is wholly dull ferruginous. *B. rufipes* var. *obscuripes* FRIESE, from Java, has dark hair on the legs, but the legs themselves are clear red.

"F. SMITH compares *B. rufipes* with *B. eximius* SM., noting the important color differences. The Sumatra specimen now before me also differs structurally, having the third antennal joint longer and the clypeus and malar space very much longer. In the long malar space, the long clypeus, shining on the disk, the bituberculate labrum, etc. it agrees with the other Sumatran forms, from which it differs totally in coloration.

"*Hab.* Sumatra. British Museum, 92 - 182."

Without doubt this species belongs to the section *Odontobombus* KRÜGER, but its subgeneric status is in doubt. The discovery of the male is needed to definitely establish its subgeneric status.

#### E. GEOGRAPHICAL SUMMARY.

It is evident from this study of the bumblebees of Java, Sumatra and Borneo, and a comparison of them with the fauna of the Asiatic Mainland, Formosa and Japan, that the East Indian species are endemic to their islands. Their affinity with the fauna of the Asiatic Mainland is still clearly shown, however, by the existence of the species *rufipes* (VOLLENHOVEN) and its color varieties. This species belongs to the subgenus *Rufipedibombus*; a subgenus which is represented in Asia and Formosa. The subgenus *Senexibombus*, proposed in this paper, is interesting in that it links up the fauna of the East Indies (*senex*) with that of the Philippines (*irisanensis*), and to date is not known from Eurasia.

It seems to the writer that not enough collecting has been done as yet to definitely establish the limits of distribution of the various species and varieties on the different islands comprising the East Indies. The present known range of the East Indian species and varieties has been tabulated for convenience as follows:



Species and Varieties	Java	Sumatra	Borneo
<i>senex</i> (VOLLENHOVEN)		×	
„ var. <i>sumatrensis</i> (COCKERELL)		×	
„ „ <i>ardentior</i> (COCKERELL)		×	
„ „ <i>pallidithorax</i> FRISON		×	
<i>melanopoda</i> (COCKERELL)		×	
<i>rufipes</i> (LEPELETIER)	×	×	
„ var. <i>flavipes</i> (HANDLIRSCH)	×		
„ „ <i>obscuripes</i> (FRIESE)	×		
„ „ <i>intermissus</i> (FRIESE)		×	
„ „ <i>richardsi</i> FRISON		×	
<i>folsomi</i> FRISON			×



## AU SUJET DE DEUX ARAIGNÉES NOUVELLES TROUVÉES DANS LES URNES DE *NEPENTHES*

par

LOUIS FAGE,

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Dans une récente étude, consacrée à une Araignée (*Misumenops nepenthi-cola* Pocock) vivant normalement dans les urnes d'un *Nepenthes* de Singapour, j'ai montré <sup>1)</sup> que seuls les *Nepenthes* du type *Nepenthes gracilis* se prêtent, de par leur structure, à l'édification de la toile, à la ponte, à l'éclosion des jeunes, en un mot à la vie permanente de l'Araignée à l'intérieur de l'urne. On sait, en effet, que ces urnes sont de deux types bien différents. Les unes, celles du *N. ampullaria* par exemple, sont revêtues, à l'intérieur, d'un épiderme fortement cuticularisé, brillant et lisse, pourvu de glandes „digestives” uniformément réparties du haut en bas; les autres, comme celles du *N. gracilis*, ont, entre le péristome et la zone brillante et lisse pourvue de glandes „digestives” qui occupe seulement ici le fond de l'urne, une zone souvent plus étendue, généralement colorée, dont la sécrétion plus ou moins cireuse n'offre aucun attrait pour les insectes qui, s'ils s'y aventurent, tombent inévitablement dans le liquide sous-jacent. Il est évident que l'Araignée ne peut habiter les urnes du type *ampullaria* puisque, immédiatement au dessous du péristome, elle-même, ses jeunes et ses oeufs se trouveraient en contact permanent avec les glandes digestives dont une sécrétion abondante serait précisément provoquée par ce contact. Dans les urnes du type *gracilis* elle trouve, au contraire, une large surface cireuse sur laquelle elle peut s'établir en toute sécurité.

Cette manière de voir est amplement confirmée par l'examen de nouveaux matériaux provenant de Madagascar et de Sumatra que m'ont respectivement soumis M.M. R. DECARY et J. C. VAN DER MEER MOHR.

\* \* \*

Il s'agit en premier lieu d'un *Theridion* (*Theridion decaryi* sp. nov. que je décris plus loin) dont M. DECARY signale, en ces termes, la présence dans les urnes du *Nepenthes madagascariensis*: „Une Araignée encore indéterminée, et que je n'ai pas rencontrée ailleurs, tisse, dans la partie supérieure du cornet, une

<sup>1)</sup> L. FAGE: Sur une Araignée vivant dans les urnes de *Nepenthes*. (*C. R. sommaire Soc. de Biogéographie* no. 24, 1926, p. 82).

—: Notes on the Fauna of Pitcher-Plants, Part IV, Araneae (*Journ. Malayan Branch, Roy. Asiatic Soc.*, VI, 1928, Pt. III, p. 13).



toile *verticale*, qui n'obstrue pas l'entrée, tout en constituant un piège excellent pour les petits Diptères" <sup>1)</sup>). Dans les notes qui accompagnent l'envoi, il est dit que l'animal „se tient caché sous le rebord enroulé de l'ouverture, où il dépose son cocon”.

Il résulte de ces indications que l'Araignée en question construit une toile verticale prenant appui sur les bords supérieurs de l'ascidie et que ni elle, ni sa progéniture ne se tient à l'intérieur de l'urne. Elle utilise comme abri la face inférieure du bourrelet formé par le péristome qui, chez cette espèce, est remarquablement développé et peut atteindre, à la partie postérieure, 13 à 14 mm. de hauteur (DUBARD 1906).

La situation du *Theridion* de Madagascar et ses rapports avec la plante apparaissent donc comme très différents de ce qu'ils sont chez le *Misumenops* de Singapour. Celui-ci vit à l'intérieur même de l'urne, tissant sa toile horizontale un peu au dessous du péristome, y déposant ses oeufs, y élevant ses jeunes.

Bien plus, tandis que le *Misumenops nepenthicola*, qui est connu de Bornéo, de Singapour et — nous allons le voir — de Sumatra, n'a jamais été pris en dehors des urnes, le *Theridion* de Madagascar, contrairement à ce que pensait M. DECARY, n'est qu'un hôte accidentel des *Nepenthes*: nous le possédons, en effet, de plusieurs localités de Madagascar, notamment de l'île Sainte-Marie et de Diégo-Suarez, situées en dehors de la zone de répartition du *Nepenthes madagascariensis*. Il vit là, comme ses congénères sur les arbustes et les buissons.

Or, ce *Nepenthes* a précisément des urnes du type *ampullaria* pourvues de glandes digestives uniformément réparties sur toute leur hauteur et fournissant un liquide qui les remplit aux trois quarts. Cette forme d'urne est donc bien inhospitalière aux Araignées qui se bornent à l'utiliser comme elles utilisent une plante, un arbuste quelconque dont l'extrémité des tiges servent de point d'appui à la toile et le bord des feuilles, maintenu enroulé à l'aide de quelques fils, d'abri pour leurs cocons. Tous les *Theridions* du groupe du *Th. pulchellum*, auquel appartient le *Th. decaryi*, agissent ainsi.

\* \* \*

Tout autre est le cas du Thomiside (*Thomisus nepenthophilus* sp. nov. décrit plus loin) observé par M. VAN DER MEER MOHR <sup>2)</sup> à Sumatra, dans les urnes du *Nepenthes tobaica*. Ce *Thomisus* se comporte exactement comme le *Misumenops* de Singapour. Il établit sa demeure dans l'urne, qui est du même type que celle du *N. gracilis*. Cette toile est horizontale et occupe tout le champ circulaire de la face interne de l'urne. En son milieu, est déposé le cocon, d'où les jeunes sortent à l'éclosion pour évoluer à l'aise dans cette zone dépourvue de glandes digestives.

M. VAN DER MEER MOHR a observé que le *Thomisus nepenthophilus* ne se

<sup>1)</sup> R. DECARY: Notes sur l'histoire et la biologie des *Nepenthes* de Madagascar (Bull. Soc. Lin. de Lyon. 7e année, no. 11, 1928, p. 91).

<sup>2)</sup> J. C. VAN DER MEER MOHR: Spinnen in *Nepenthes*-Bekers (De Tropische Natuur, 1929. p. 73).



rencontre que dans les urnes du *Nepenthes tobaica*, bien qu'il existe, dans les mêmes parages, d'autres *Nepenthes* comme le *N. reinwardtiana* dont les urnes sont semblablement constituées. Mais chez celui-ci, il a seulement retrouvé le *Misumenops nepenthicola* qui vit à Bornéo et à Singapour dans les urnes du *Nepenthes gracilis*.

Cette trouvaille montre que, si le „choix” de l'Araignée est déterminé avant tout par la structure de l'urne, d'autres facteurs entrent en jeu qui limitent ce choix tantôt à une seule espèce de *Nepenthes*, tantôt à plusieurs espèces voisines. Me basant sur le fait que, lorsque l'Araignée est inquiétée, elle ne cherche pas à sortir de sa retraite, mais se laisse choir au bout d'un fil au fond de l'urne et entre ainsi en contact direct avec le liquide que celle-ci contient, errant sans dommage parmi les cadavres en partie digérés des Insectes capturés, jusqu'au moment où elle regagne son poste — j'avais suggéré que la composition même du liquide de la plante devait jouer un rôle important dans les rapports entre Araignée et *Nepenthes*. M. CEDRIC DOVER <sup>1)</sup> a bien voulu faire quelques expériences comparatives sur le pouvoir digestif du liquide des urnes des trois espèces de *Nepenthes* de Singapour et il a constaté, en effet, que le suc des urnes du *Nepenthes gracilis*, hôte du *Misumenops*, est très peu abondant et beaucoup moins actif que celui du *Nepenthes rafflesiana* et surtout que celui du *N. ampullaria*.

Nous pouvons donc conclure que les rapports des Araignées et des *Nepenthes* sont déterminés en premier lieu par la structure des urnes: il ne peut y avoir commensalisme réel et établissement de l'Araignée à l'intérieur de l'urne que si celle-ci est du type *gracilis*, c'est-à-dire pourvue d'une zone „neutre” entre le péristome et la zone glandulaire — et que, parmi les urnes rentrant dans cette catégorie, celles dont le liquide est le moins actif sont de préférence habitées.

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Une dernière remarque mérite enfin d'être faite, à savoir que les seules Araignées actuellement connues comme réellement commensales des *Nepenthes*, c'est-à-dire vivant normalement à l'intérieur de leurs urnes, appartiennent à la même famille, celle des *Thomisidae*. Il n'y a pas lieu de s'étonner qu'un *Misumenops* ou un *Thomisus*, dont les nombreuses espèces vivent habituellement sur les fleurs et capturent les Insectes qui viennent visiter celles-ci, aient adopté ce genre de vie; mais il est surprenant que parmi tant d'autres Araignées sédentaires à moeurs semblables, parmi les Argiopides et les Thérédides notamment, aucune n'ait adopté ce même comportement, car le *Theridion* de Madagascar ne nous montre qu'un essai timide dans cette voie. Faut-il admettre, chez les seuls Thomisides, ainsi que le suggère C. DOVER pour les larves de Culicides évoluant dans le liquide des urnes, la possibilité d'élaborer quelque antipepsine, les mettant à l'abri des dommages que leur causerait le contact des glandes digestives des *Nepenthes*?

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<sup>1)</sup> Journ. Malayan Branch, Roy. Asiatic Soc., VI, 1928, op. cit., p. 19, en note.



## DESCRIPTION DES ESPÈCES NOUVELLES.

**Theridion decaryi** sp. nov.

FEMELLE. — Céphalothorax fauve: une fine ligne marginale et une large bande médiane noires, celle-ci rétrécie au milieu. Yeux médians en trapèze aussi long que large. Chélicères beaucoup plus longues que le bandeau. Plastron fauve, rembruni sur les bords. Pattes fauves avec l'extrémité des articles rembrunie et souvent une tache brune médiane à la face interne des tibias. Abdomen ovale, blanc mat avec les parties latérales et le ventre fauve obscur et une bande médiane dorsale brun foncé, festonnée sur ses bords. Epigyne (fig. 1) en fente transverse, marquée de plis horizontaux et limitée en arrière par un record chitinisé émettant un court crochet redressé.

Long. 3,5 - 4 mm.

MÂLE. — Pattes de la première paire beaucoup plus longues que les autres, leur fémur épais, longuement atténué à la base, leur tibia légèrement épaissi

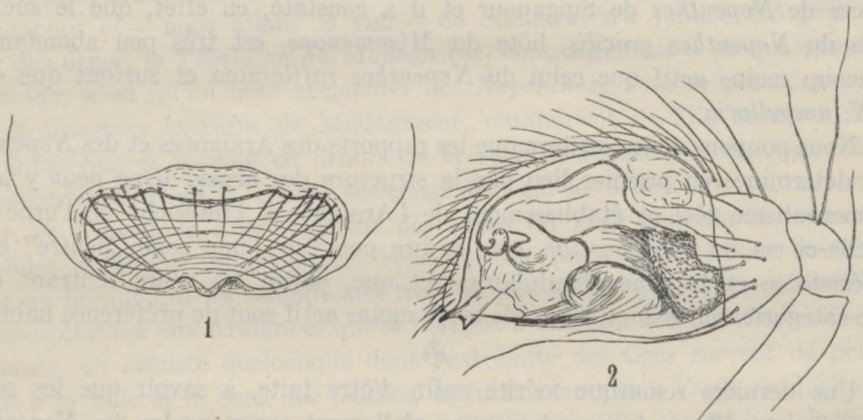


Fig. 1. *Theridion decaryi*, épigyne. — Fig. 2. *Id.*, ♂, patte-mâchoire, côté externe.

vers l'extrémité, leur métatarse armé en dessous, au bord interne, de 8 à 9 courtes épines unisériées. Tibia de la patte-mâchoire vu par la face externe (fig. 2) tronqué, vu en dessus plus long que la patella; tarse plus grand que le fémur. Bulbe pourvu d'une épaisse lame recourbée en avant et terminé en arrière par une forte saillie spinuleuse; style long et aigu, sa pointe aboutissant à une pièce membraneuse, bifide, concave du côté externe.

Long. 3 - 3,5 mm.

HABITAT. — Madagascar: environs de Fort-Dauphin (DECARY), sur les urnes du *Nepenthes madagascariensis*; île Sainte-Marie (MOCQUARY); Diégo-Suarez (ALLUAUD), sur les buissons.

Cette espèce appartient au groupe du *Theridion pulchellum* WALCK. et possède en commun avec celui-ci et le *Th. vittatum* C. K. l'armature spéciale des métatarses de la première paire, ainsi que le crochet du bord postérieur



de l'épigyne. Mais elle est particulièrement remarquable par la complexité de l'organe copulateur du mâle.

***Thomisus nepenthiphilus* sp. nov.**

FEMELLE. — Céphalothorax et pattes antérieures fauve testacé; espace oculaire blanc mat, tubercules oculaires aigus dépassant largement en dehors les yeux latéraux, leur extrémité rougeâtre; pattes postérieures et abdomen blanc jaunâtre mat, celui-ci pentagonal avec les angles latéraux saillants. Bandeau lisse, très faiblement oblique. Yeux médians égaux aux latéraux, mais les antérieurs séparés entre eux par un intervalle égal à 1 fois  $\frac{1}{2}$  celui qui les sépare des latéraux. Quelques courtes épines sur la face antérieure du fémur I et, ainsi qu'au fémur II, une épine dorsale; deux rangées inférieures (4 - 2 ou 3 - 1) d'épines tibiales et deux rangées (6 - 4 ou 4 - 4) d'épines métatarsales. Epigyne (fig. 3) présentant au milieu une plage lisse vaguement cordiforme, ouverte en avant, rétrécie en arrière et limitée sur les côtés par les réceptacles séminaux chitinisés fauve-rougeâtre.

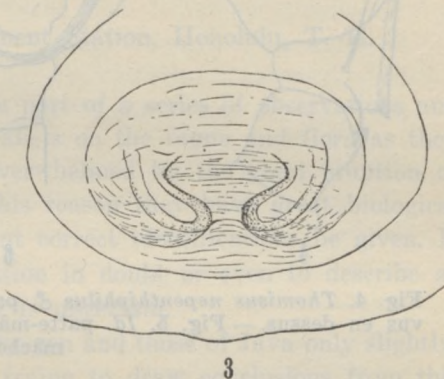


Fig. 3. *Thomisus nepenthiphilus*, épigyne.

Longueur: 10 mm.

MÂLE. — Coloration fauve rougeâtre, sauf les deux paires de pattes postérieures plus claires. Tégument garni de granulations surmontées de crins courts. Abdomen de même forme que chez la ♀, mais revêtu d'un scutum dorsal le recouvrant presque en entier et bordé par de courts et robustes spicules; région épigastrique indurée. Une forte saillie dentiforme sur la face externe des chélicères. Aux tibias des pattes antérieures: 1 - 1 et aux métatarses 3 - 3 épines inférieures.

Tibia de la patte-mâchoire (fig. 4 et 5) un peu plus court que la patella, celle-ci pourvue d'une apophyse externe dentiforme, chitinisée noire. Apophyse externe du tibia vue de profil accolée au tarse, en forme de croissant à pointes aiguës et saillantes; apophyse inférieure courte, aussi large que longue, aplatie à l'extrémité. Pointe du tarse bien détachée. Bulbe (fig. 6) discoïde, bordé à la partie antérieure par la portion libre du style dont la base est insérée au tiers antérieur du bulbe.

Longueur: 3,5 mm.

HABITAT. — Sumatra, dans les urnes du *Nepenthes tobaica* (VAN DER MEER MOHR): Sosorladang, 8-VIII-1928, 5 ♀, 1 ♂, nombreux juv.; Rahoetbosidolok, 2-VIII-1929, 6 ♀; Maranti, 17-VIII-1929, 1 ♂, 2 ♀.

Cette espèce est extrêmement voisine du *Thomisus callidus* (THOR.) de l'île de Nias, sur la côte W. de Sumatra. Il s'en distingue par sa taille nettement



plus grande (le ♂ du *T. callidus* mesure seulement 2 mm.), par l'armature des tibias et des métatarses antérieurs qui sont inermes chez *callidus*, par son bandeau lisse, dépourvu du trapèze de granulations pilifères caractéristique de

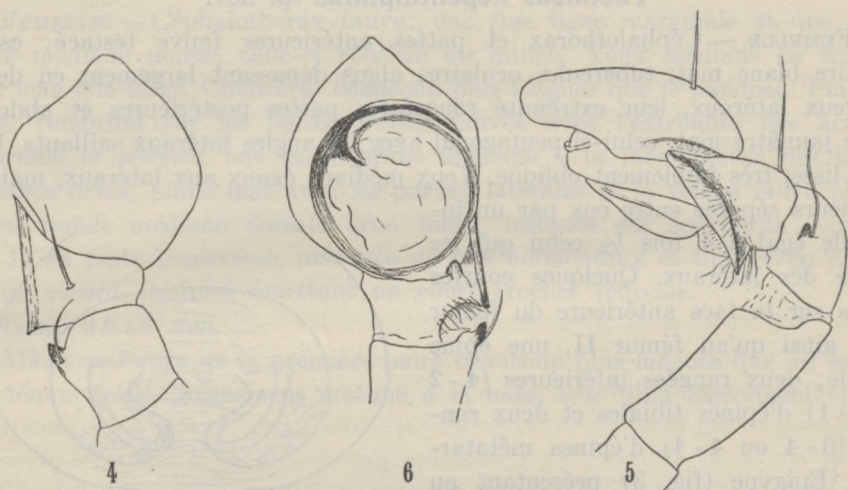


Fig. 4. *Thomisus nepenthophilus* ♂, patella, tibia et tarse de la patte-mâchoire vus en dessus. — Fig. 5. *Id.* patte-mâchoire, côté externe. — Fig. 6. *Id.* patte-mâchoire vue en dessous.

l'espèce de THORELL et par ses yeux égaux. J'ajouterai que chez le *T. nepenthophilus*, les pattes antérieures, surtout les fémurs sont beaucoup plus grêles, que les réceptacles séminaux ne figurent point ici un V que, chez le ♂, la pointe du tarse de la patte-mâchoire est nettement plus longue et l'insertion du style visiblement plus antérieure.

Ces caractères différentiels sont suffisants pour séparer les deux espèces dont les affinités demeurent néanmoins des plus étroites.

\* \*

Je rappelle que le *Misumenops nepenthicola* (Poc.) a été trouvé par M. VAN DER MEER MOHR, dans les urnes du *Nepenthes reinwardtiana*, et dans les localités suivantes: Sumatra: Tinggi Radja, 9-IX-1928, 1 ♂, 1 ♀; Rahoetbosidolok, 11-VIII-1929, 3 ♀; Maranti, 17-VIII-1929, 1 ♀, 2 ♂ juv.

Paris, le 19 Octobre 1929.



## ON A SMALL COLLECTION OF FULGORIDS FROM THE ISLANDS OF KRAKATAU, VERLATEN AND SEBESI.

By

F. MUIR,

Hawaiian Sugar Planters' Experiment Station, Honolulu, T. H.

The collection dealt with herein form part of a series of observations and collections made by various Dutch naturalists on the fauna and flora as they reappear on those islands which were overwhelmed by the great eruption of the volcano of Krakatau in 1883. For this reason they have great biological interest and it is of great importance that correct identifications be given. It is therefore better to leave an identification in doubt or even to describe as new specimens whose specific distinction is uncertain.

The fulgorids of Sumatra are hardly known and those of Java only slightly, so that we are at a disadvantage when trying to draw conclusions from this group of insects. The establishment of phytophagous insects in a new locality presupposes the establishment of their host plants; more species of phytophagous insects must migrate into a new region than can be established. Fulgorids have but small power of flight, so their appearance on these islands is of interest. Grass-feeding insects have a better chance of dispersal than most of the others as grasses are so prevalent. Of the three species of *Cixiidae* mentioned below two are known to feed on grasses; of the eight species of *Delphacidae*, *Ugyops* is not like to feed on grasses but the other seven are. The adult *Derbidae* are not likely to feed on grasses, but they are likely to feed on palms; the young of these all live in rotten wood so that considerable forest growth with some decay is necessary for their survival. The two species of *Nisia* are probably grass feeders. The *Derbidae* have poor power of flight and their incident of endemism in islands is high; the possibility of the nymphs being carried in old logs must be considered.

### FULGOROIDEA.

#### CIXIIDAE.

1. ***Kirbyana javana* MUIR.**

One male and one female from Sebesi (DAMMERMAN, April 1921). This is known from Java and Sipora.



2. **Dystheatias deventeri** KIRKALDY.

One female from Krakatau (DAMMERMAN, September 1920). Hitherto only known from Java.

3. **Oliarus dispar** MUIR.

Three males from Krakatau (DAMMERMAN, December 1919; September 1920) and one female from Verlaten Island (DAMMERMAN, December 1919). Originally described from Java, Pekalongan.

## DELPHACIDAE.

4. **Ugyops notivena** (WALKER)?

Six specimens from Krakatau and one from Sebesi. Only a comparison with the type can make this identification certain.

5. **Tropidocephala** sp. Fig. 1.

There is a damaged male of this genus without the head and pronotum, which appears to be undescribed. I give a figure of the genitalia and the following description for future reference. Black or very dark brown, the legs lighter. Tegmina black or very dark brown, a very small light mark at node. The corium and clavus covered irregularly with small granules bearing black hairs, the membrane (distad of nodal line) having fewer confined to the membrane near the nerves. The genitalia are typically those of *Tropidocephala*; the tegmina are somewhat like those of *Paranda globiceps*.

One male from Krakatau (DAMMERMAN, September 1920).

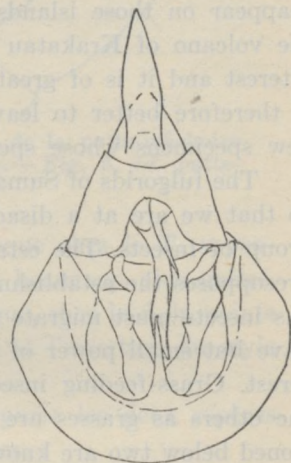


Fig. 1. — *Tropidocephala* sp, Full view of male genitalia.

6. **Tropidocephala** sp.

There is one female specimen which may be a light form of *T. brunnipennis* SIGN.

Hab. Krakatau (DAMMERMAN, Dec. 1919).

7. **Eoeuryrsa flavocapitata** MUIR.

One male and two females from Krakatau (DAMMERMAN, September 1920). Formerly known from China and Federated Malay States.

8. **Dicranotropis** sp.

One female which I do not care to place a specific name to.

Hab. Krakatau (DAMMERMAN, September 1920).



9. *Nilaparvata lugens* (Stål).

Three female specimens from Sebesi (DAMMERMAN, April 1921).

This is a widely distributed species first described from Java.

10. *Sogata intrudens* sp. n. Figs. 2, 3.

Male: length 2.3 mm; tegmen 2.7 mm.

Vertex very slightly longer than wide, base slightly wider than apex, the medio-lateral carinae arising from the lateral carinae about the middle and continued into the frons, the basal medial carina obscure. Length of frons nearly double the width, base narrower than apex, sides slightly curved, median carina narrowly forked at base. Antennae reaching nearly

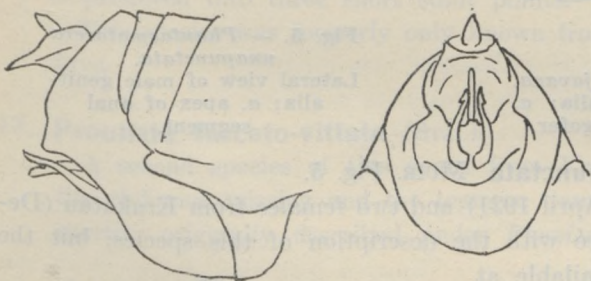


Fig. 2-3.—*Sogata intrudens*.

2. Lateral and 3. full view of male genitalia.

to middle of the clypeus, second segment nearly 1.5 time the length of first. Lateral pronotal carinae nearly straight, diverging posteriorly, not quite reaching the hind margin. Hind basitarsus slightly longer than the other two together; spur not so long as basitarsus, thin, tectiform, with about twenty

five teeth on the hind margin. The lateral and full view of the genitalia figured; there is no armature on the anal segment.

Light brown; a few lighter spots on frons, darker over abdomen. Tegmina hyaline, slightly stramineous, veins brown, more distinctly so on veins apical of cross veins, a dark mark on margin at apex of clavus; wings hyaline, veins brown.

The female is a little larger and darker in colour than the male.

Hab. Verlaten Island. One male and one female (DAMMERMAN, Sept. 1920).

11. *Sogata furcifera* (HORVÁTH).

One male from Sebesi of this widely distributed species (DAMMERMAN, April 1921).

## DERBIDAE.

12. *Phaciocephalus* sp.

A dark, female specimen from Sebesi without a head which I do not care to put a name to. (DAMMERMAN, April 1921).

13. *Kamandaka (Eosaccharissa) javana* KIRK. Fig. 4.

The type of this species is lost but the one male from Krakatau (December 1920) agrees with the original description. I figure the genitalia which should be compared with specimens from sugar cane in Java.



The apex of the anal segment is produced into two sharp spines; the medio-ventral process is long and thin.

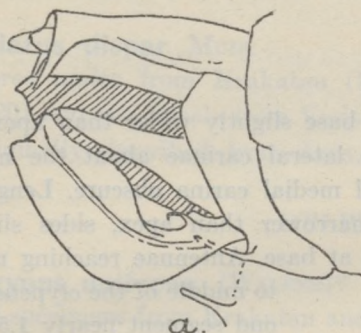


Fig. 4. — *K. (Eosaccharissa) javana*. Lateral view of male genitalia; a. medio-ventral process of pygofer.

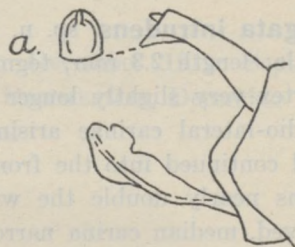


Fig. 5. — *Phantasmatocera unapunctata*. Lateral view of male genitalia; a. apex of anal segment.

14. ***Phantasmatocera unopunctata*** MUIR. Fig. 5.

Two males from Sebesi (April 1921) and two females from Krakatau (December 1919) which agree with the description of this species, but the type specimen is not available at present for detailed comparison of the male genitalia. It was reported, with some uncertainty, from Siberut Island.

15. ***Kaha peregrina*** sp.n. Figs 6,7, a,b.  
Male: length 2.3 mm; tegmen 3.8 mm.

Head not so greatly produced as in type species, produced in front of eye about the length of an eye. The second segment of antenna produced into two portions, one of which bears long, narrow scales.

Reddish brown; the vertex and base of frons light. Tegmina and wings reddish brown with darker veins; the veins in costal cell and the apical veins narrowly bordered with white.

The genitalia are figured. They come near to *K. pseudomedia* MUIR from the Philippine Islands, but it is not that species.

One male from Krakatau (December 1919).

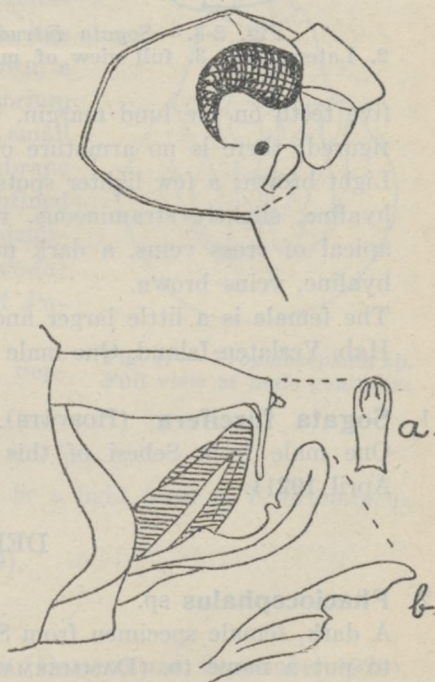


Fig. 6-7. — *Kaha peregrina*. 6. Lateral view of head. 7. Lateral view of male genitalia; a. apex of anal segment; b. ventral view of left genital style.



16. ***Proutista fenestrata*** (BIERMAN) Fig. 8.

Two males from Sebesi (DAMMERMAN, April 1921) which agree with the description of this species. The genitalia are figured. The anal segment is long and narrow, slightly bent ventrad about one fourth from the apex; at the bend there is a slight projection on each side. The genital styles are long, thin and cylindrical on apical two thirds, the apex slightly swollen and produced into two short processes. In *P. wildmani* from Formosa, the apex of the anal segment is produced into three short stout points.

This species was formerly only known from Java.

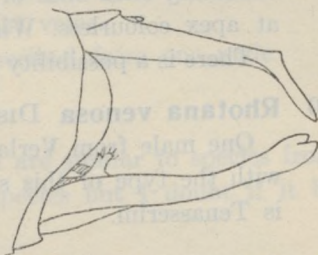


Fig. 8. — *Proutista fenestrata*.  
Lateral view of male genitalia.

17. ***Proutista furcato-vittata*** (Stål).

A second species of this genus from Krakatau (September 1920) has the abdomen missing and the tegmina damaged but I think it is Stål's species, originally described under *Phenice*.

18. ***Zoraida (Peggiopsis) javana*** (MELICHAR).

One female from Sebesi (DAMMERMAN, January 1922), which agrees with the description. The hind margin of the pregenital plate very slightly rounded. Anal segment wide, about as long as broad, subcircular with a small projection at the apex. Formerly known only from Java.

19. ***Zoraida (Zoraida) pseudosylvicola*** MUIR (?) Fig. 9, a.

This species was described from a female from Borneo, Telok Air, and agrees with a male from Krakatau (September 1920), but until it

can be compared with a male from Borneo there must be some uncertainty of the identification. The genitalia come near to those of *Zoraida laratae* MUIR. I give a figure and description for comparison.

Male: length 3.6 mm; tegmen 9 mm; wing 4.2 mm.

Antennae 1.5 times the length of frons, slightly flattened, sense organs evenly distributed over surface. The sulca down frons fairly large.

Clypeus longer than frons, median and lateral carinae distinct, sides flattened. First median sector furcate, joined to Cu making it four veined; four simple median sectors. Wings about half the length of the tegmina.

Stramineous; mesonotum darker. Abdominal tergites darker brown with

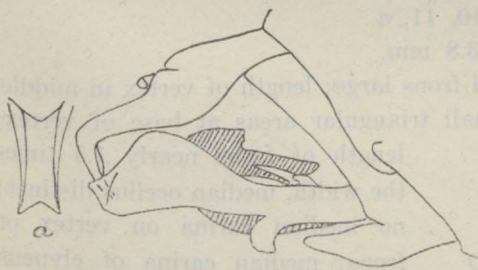


Fig. 9. — *Zoraida pseudosylvicola*?  
Lateral view of male genitalia; a. apex of anal segment.



distinct light pustles or sense organs, largest on sixth tergite. Anal segment darker brown, genital styles light. Tegmina hyaline; the costal, subcostal, radial, basal, medial and half of second median cells brown, the colour extending onto base of median sectors; veins brown, apices of R and M at apex colourless. Wings hyaline with brown veins.

There is a possibility of *laratae* being only a colour variety of this species.

20. **Rhotana venosa** DISTANT.

One male from Verlaten Island (DAMMERMAN, April 1920) which agrees with the type of this species. The only other locality it is reported from is Tenasserim.

21. **Zeugma vittata** WESTWOOD.

One female from Sebesi (DAMMERMAN, April 1921).

This is the same as *Z. monticola* KIRK. and is known from Java, Borneo and the Malay Peninsula. A closely allied species, *Z. corporaali*, is known from Sumatra. One species from Siberut and one from Sipora are also known.

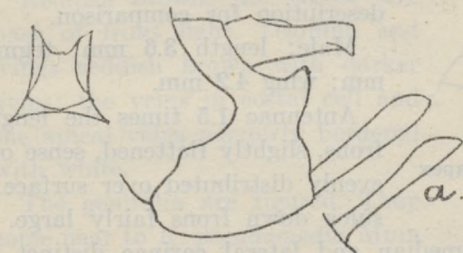
### MEENOPLIDAE.

The species of the genus *Nisia*, in common with the species of all the genera of this family, are only recognized with any certainty by the genitalia, and as most species have been described without even a reference as to the sex it is nearly impossible to be sure of identifications. Under the name of *Nisia atrovenosa* (LETH.) stand specimens from various localities and they represent more than one species. As the genitalia of the male of this species from the typical locality has never been described it is impossible to be sure of its identification; it is therefore better to describe as new those specimens whose identification is uncertain, rather than make more wrong identifications.

22. **Nisia dammermani** sp.n. Figs. 10, 11, a.

Male: length 2.7 mm; tegmen 3.8 mm.

The lateral carinae of vertex and frons large; length of vertex in middle, equal to width in middle, two small triangular areas at base of vertex;



length of frons nearly 1.5 times the width, median ocellus distinct; no median carina on vertex or frons; median carina of clypeus distinct, lateral carinae absent or very obscure. Venation of tegmen typical; first claval vein strongly granulate, Sc + R slightly so.

The genitalia are figured. The genital styles are simple, straight and narrow with rounded apex

Fig. 10-11. — *Nisia dammermani*.  
10. Dorsal view of head. 11. Lateral view of male genitalia; a. ventral view of genital style.



which is very distinct from the styles of *atrovenosa* from several localities.

Light brown; darker on carinae of vertex and frons and over abdomen. Tegmina hyaline, slightly stramineous, veins darker brown except the Sc + R which is light. The costal margin is light; very slightly fuscous along margin of apical cells. Wings hyaline with light veins.

Hab. Sebesi (DAMMERMAN, April 1921). Described from one male.

23. **Nisia atrovenosa** (LETH.)

Two males and one female (damaged) which are similar to species from Queensland and elsewhere identified as this species but I doubt if it be correct. Sebesi (DAMMERMAN, April 1921).







## FISH EGGS AND LARVAE FROM THE JAVA SEA <sup>1)</sup>.

By

Dr. H. C. DELSMAN

(Laboratorium voor het Onderzoek der Zee, Batavia)

### 14. The genus *Pellona*.

In the surface catches made along the east coast of Sumatra and the north coast of Java certain eggs may be found which, by the foamlike, segmented, structure of the yolk, may be recognized at once as belonging to clupeiform fishes. They contain one or more oil-globules and the egg-membrane, which is wholly filled up by the egg, is surrounded by a layer of gelatinous colourless substance.

As an example, I give first the description of an egg which was found fairly regularly in the surface catches made near the north coast of Krawang, east of Batavia, and near Cheribon (fig. 1). It has a diameter of 1.47 - 1.55 mm, without the gelatinous coat. The outer diameter, including the latter, is about 1.77 - 1.89 mm. There is one oil-globule, which has a diameter of 0.35 mm. It is colourless or slightly pink or brownish.

I have found these eggs repeatedly, though never in considerable quantities, in the localities mentioned above, near the coast. On two occasions, when I determined the salinity of the water in which they were found, this proved to be 29.2 ‰ and 29.6 ‰ resp.

At daybreak, 6 a.m., the eggs contain the rudiment of an embryo encircling about 180° of the yolk circumference. It seems probable, from this, that spawning has occurred in the evening, as is the case with many marine fishes.

The egg represented in fig. 1 has been drawn at 9.30 a.m. The rudiment of the embryo encircles nearly 270° of the yolk circumference now. The heart is beating, and a few black pigment spots have appeared. One situated dorsally, behind the ear vesicle and above the foremost myotome, is especially conspicuous. A few smaller ones are situated more backward, near the future anus.

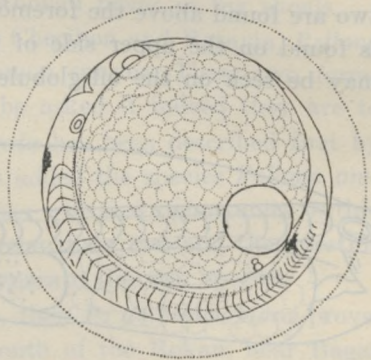


Fig. 1. Egg of *Pellona elongata*,  $\times 26$

<sup>1)</sup> cf. Treubia Vol. II p. 97, Vol. III p. 38, Vol. V p. 408, Vol. VI p. 297, Vol. VIII p. 199 and p. 389, Vol. IX p. 338 and Vol. XI p. 275.



The larvae hatch between 2 and 3 p.m. and may be recognized at once as belonging to the clupeoid type, firstly by the elongated shape and secondly by the backward situation of the anus. If we compare them with the larvae of the genus *Clupea* we see at once that they are considerably larger, fully  $1\frac{1}{2} \times$  as long e.g. as those of *Clupea jimbriata* (cf. Treubia Vol. VIII). Another difference is found in the shape of the yolk, which in young *Clupea*-larvae

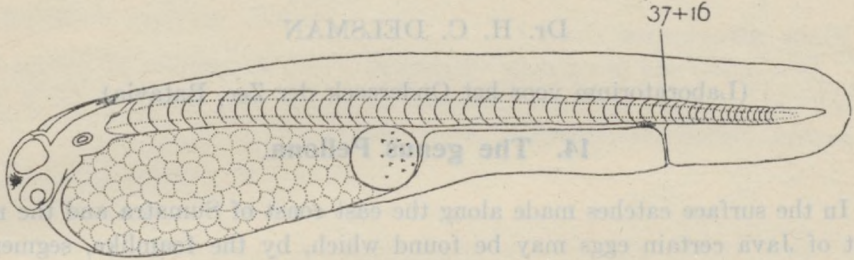


Fig. 2. Newly hatched larva from same,  $\times 26$ .

is more rounded than in our present larvae. This is evident especially at the posterior extremity of the yolk. We find the yolk tapering gradually into the gut as is the case with many clupeiform larvae (*Chanos*, *Dussumieria*, *Chirocentrus*, *Engraulis*, *Stolephorus*) but not with those of *Clupea*. The oil-globule is situated in the posterior part of the yolk.

For the number of myotomes I found  $37 + 16$  in the newly hatched larva,  $37 + 13$  in the somewhat older ones. The unsegmented or indistinctly segmented part behind the last complete myoseptum is counted for one, in the same way as, in determining the number of vertebrae in the adult fish, we count the urostyl as one vertebra. The muscle fibres in the myotomes show the crossed arrangement which is characteristic for the larvae of clupeiform fishes (cf. Treubia III, p. 40).

A few black pigment spots are quite evident in the newly hatched larva. One of them is situated along the end of the gut, right over the anus. One or two are found above the foremost myotome, behind the ear vesicle. One, finally, is found on the upper side of the head, above the eyes. A few pigment spots may be seen on the oil-globule also.

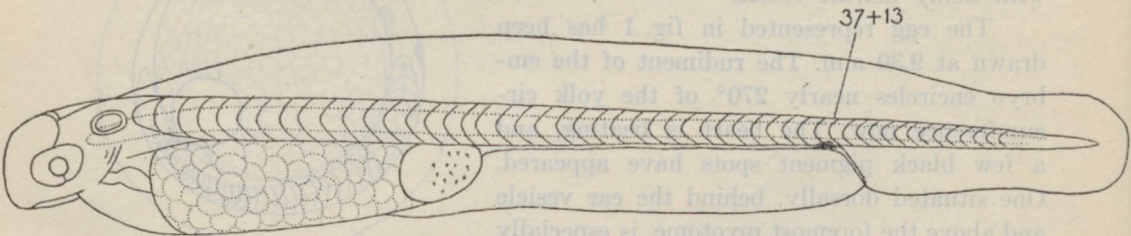


Fig. 3. Larva of the next morning,  $\times 26$ .

During the development of the larva these pigment spots disappear, with the exception of the one at the end of the gut, as may be seen from the figs.



3 and 4. These figures show that development proceeds in the usual way. Fig. 3 shows a larva on the morning of the first day after hatching, fig. 4 one on the morning of the second day. The eyes have become black then, although the yolk has not yet been absorbed. I did not succeed in rearing the larvae up to the third day.

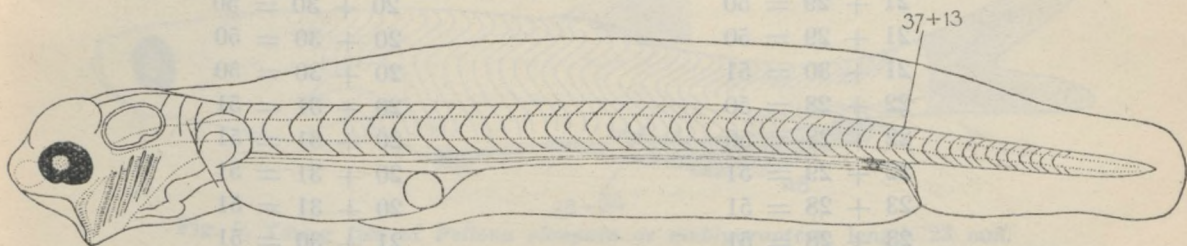


Fig. 4. Larva of the second morning,  $\times 26$ .

In looking now for the origin of these eggs, one might hesitate between the following genera of clupeiform fishes, all coast forms and having a number of vertebrae of about 50: *Pellona*, *Setipinna* and *Opisthopterus*. I counted e.g.

in <i>Pellona elongata</i>	$21 + 29 = 50$
„ <i>amblyuropterus</i>	$20 + 30 = 50$
<i>Setipinna taty</i>	$15 + 31 = 46$
„ <i>melanochir</i>	$18 + 32 = 50$
„ <i>breviceps</i>	$17 + 37 = 54$
<i>Opisthopterus tartoor</i>	$17 + 33 = 50$

Examination of the ripe ovarian eggs of species of *Pellona*, however, shows at once the gelatinous layer which is so characteristic for the eggs dealt with in this article, so that the conclusion is not difficult.

Species of *Pellona*, known as *ikan puput*, are caught fairly regularly in coastal waters of the Indian Archipelago, although never in big shoals.

Along the north coast of Krawang and near Cheribon and Batavia, *Pellona elongata* and *amblyuroptera* are the most common species. These two forms are so closely related that the question might be asked if indeed they are to be considered as different species. *Pellona elongata* has been described first by BENNET in 1830. Afterwards BLEEKER (1852) has added the species *Pellona amblyuropterus*. I hope my assistant Dr. HARDENBERG will find opportunity within short to study more closely the differences between these two and the question whether they are of sufficient importance to separate the two species.

If provisionally we assume the latter case, then *P. amblyuroptera* proves to be the form common in the estuary-like mouth of the Rokan, near Bagan Si Api Api. At the fish market of Batavia, as BLEEKER himself points out, both species may be found but *P. elongata* is the more common one. For the number of vertebrae in ten samples of each Dr. HARDENBERG found:



<i>Pellona elongata</i> (fish market Batavia)	<i>Pellona amblyuroptera</i> (smaller specimens, from Bagan Si Api Api)
21 + 29 = 50	20 + 30 = 50
21 + 29 = 50	20 + 30 = 50
21 + 29 = 50	20 + 30 = 50
21 + 29 = 50	20 + 30 = 50
21 + 30 = 51	20 + 30 = 50
22 + 28 = 50	20 + 31 = 51
22 + 28 = 50	20 + 31 = 51
22 + 29 = 51	20 + 31 = 51
23 + 28 = 51	20 + 31 = 51
23 + 28 = 51	21 + 30 = 51
Average: 21.7+28.7=50.4	20.1+30.4=50.5

The total number of vertebrae appears to be almost the same, but in *Pellona amblyuroptera* the anus appears to lie more forward, the difference being about  $1\frac{1}{2}$  vertebrae. Unfortunately Dr. HARDENBERG has had no opportunity yet to examine in a similar way some 10 samples of *Pellona amblyuroptera* from Batavia or Krawang. In one specimen he found  $22 + 29 = 51$  vertebrae which seems to differ from the *P. amblyuroptera* from Bagan and to approach the average for *P. elongata*!

It seems, then, somewhat difficult to make out whether the egg described above is to be ascribed to *P. elongata* or to *P. amblyuroptera*, or, perhaps, to a species comprising both and which then must bear the name *P. elongata*. Provisionally I assume that it belongs to *P. elongata* s.s. A quite similar but slightly bigger egg to be described next and which I found often near the river mouths of the east coast of Sumatra, may be considered in that case as belonging to *P. amblyuroptera* which is common there (fig. 6).

For the diameter of ripe ovarian eggs of *Pellona elongata* and *amblyuroptera* I found about 0.8 - 0.9 mm excl. the jelly coat. This tallies well with what I found in several fishes, viz. that the diameter of the pelagic eggs is nearly twice that of the ovarian eggs.

A comparison of the number of myotomes of the larva with the number of vertebrae in the adult shows that we must assume a forward shifting of the anus during early development over a considerable distance, corresponding to about 15 myotomes. We find:

Nr. of the myotomes in the larva:  $37 + 13 = 50$

Nr. of the vertebrae in the adult:  $21.7 + 28.7 = 50.4$

This forward shifting of the anus during the larval development has been observed by me in all elupeiiform fishes whose development I have studied. It is not astonishing that it should be particularly pronounced in those genera where a phylogenetic forward movement of the anus has evidently occurred, as e.g. in *Pellona*.



Fig. 5 shows a larva caught in the egg net and which has a length of 23 mm. Probably it belongs to the same species. In front of the anus we count here 28 myotomes which shows that the forward shifting of the anus has proceeded about halfway here. The ventral fins have only just appeared. It seems

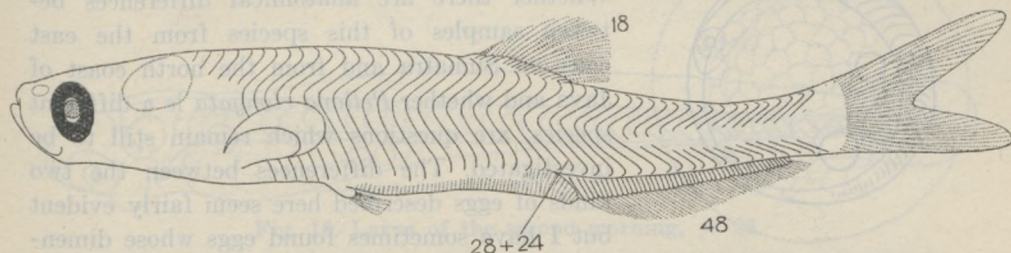


Fig. 5. Young fish of *Pellona elongata* or *amblyuroptera*, length 23 mm.

that also the dorsal fin moves forward during development. I have not been able to trace its first appearance, but in fig. 5 the anterior end of the dorsal fin lies over the 22nd myotome, whereas in the adult I found this to be the 17th myotome. In the adult the anterior end of the dorsal fin lies about right above the ventral fins, in the larva of fig. 5 a considerable distance behind it. If the situation of the dorsal fin remained constant during the forward shifting of the anus, we ought to find the anus in the adult right below the beginning of the dorsal fin, about the 22nd myotome. This, however, is not the case, it still lies a number of myotomes in front of the anus.

I observed indications of a similar forward shifting of the dorsal fin during development in *Chirocentrus* (cf. Treubia VI p. 306), and probably this will prove to be a phenomenon to be observed in all clupeid larvae, though not always in an equally pronounced manner.

In the estuary of the Rokan, at Bagan Si Api Api (Sumatra), *Pellona amblyuroptera* is the common species. Here, and also near the mouth of the Indragiri (Amphitrite Bay, Sumatra), I found more than once an egg closely resembling the one described above, but somewhat larger. Its diameter amounted to 1.6 (once even to 1.7), with the gelatinous coat to nearly 2 mm (once even to 2.25 mm). It is shown in fig. 6.

The larvae hatched in the afternoon. In the same way as the eggs, they also show a great resemblance to those described above without, however, being perfectly identical. As might be expected, their size appears to be slightly larger than that of the latter. The number of myotomes in front of the anus appears to be nearly the same: I counted 36 (-37)

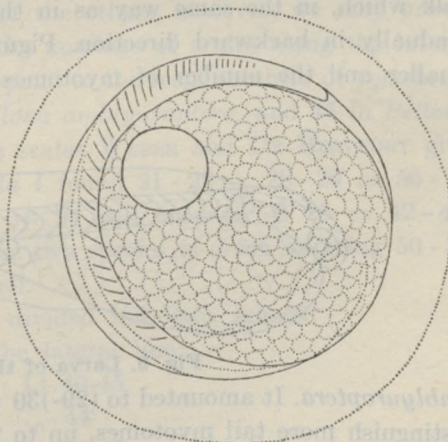


Fig. 6. Egg of *Pellona amblyuroptera*,  $\times 26$ .



besides some 13 tail myotomes. Black pigment spots were present on the head, over the first myotome, on the surface of the oil-globule and near the anus.

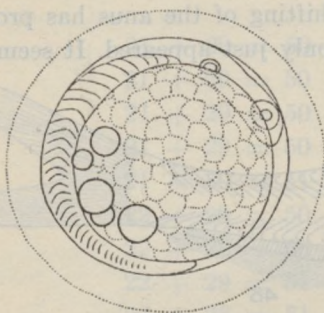


Fig. 7. Egg of *Pellona ditchoa*,  $\times 26$ .

An egg closely related to the two described above was found more than once by me on the east coast of Sumatra near the mouths of the Rokan (Bagan Si Api Api) and the Indragiri (Amphitrite Bay). Besides the segmented yolk it also had the gelatinous coat which is characteristic for the former. Sometimes the two eggs were found together in the same catches. For the diameter of this latter egg (fig. 7) I found 1.18 - 1.34 mm, or, the gelatinous coat included, 1.47 - 1.71 mm.

The main characteristic was the presence of 5-6 colourless oil-globules at the vegetative pole of the egg, i.e. in the neighbourhood of the vent of the developing embryo.

In the newly hatched larva they are found in the posterior part of the yolk which, in the same way as in the egg of *Pellona amblyuroptera*, tapers gradually in backward direction. Pigment is absent in the larva. The size is smaller and the number of myotomes is lower than in the larva of *Pellona*

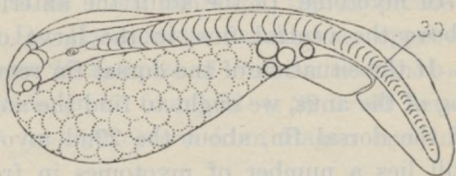


Fig. 8. Newly hatched larva from same,  $\times 26$ .

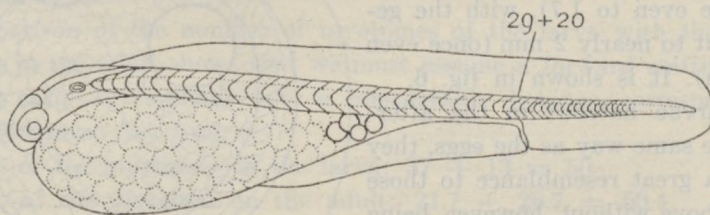


Fig. 9. Larva of the next day,  $\times 26$ .

*amblyuroptera*. It amounted to (29-)30 + 15. Only in very young larvae could I distinguish more tail myotomes, up to 20. But this is often the case in clupeid larvae, a few tail myotomes appear not to develop, they disappear during further development.



Now my assistant, Dr. HARDENBERG, has had a fine opportunity of studying the fish fauna of Bagan Si Api Api during a month's stay there. He finds that two species of *Pellona* are characteristic for this region, these being *Pellona amblyuroptera* and the smaller *Pellona ditchoa*.

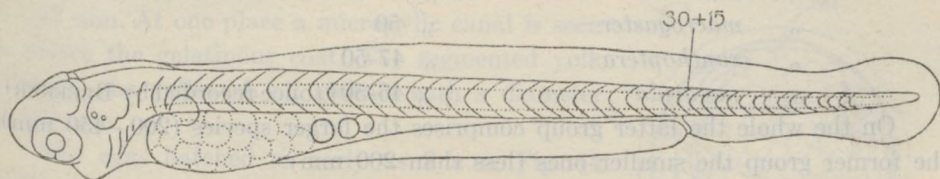


Fig. 10. Larva of the second morning,  $\times 26$ .

The former attains a length of 450 mm, the latter of 160 mm only (according to WEBER and DE BEAUFORT). The former has, as mentioned already, about  $21 + 29 = 50$  vertebrae, the latter  $19 + 26 = 45$  vertebrae. These latter numbers tally very well with those of the myotomes of our larva, if only we assume again the usual forward movement of the anus during development. We find:

	Nr. of larval myotomes.	Nr. of vertebrae in the adult.
<i>Pellona elongata</i>	$37 + 13 = 50$	$21,7 + 28,7 = 50,4$
„ <i>ditchoa</i>	$30 + 15 = 45$	$19 + 26 = 45$

In the larger species we find a forward displacement of the anus over a distance of 15 myotomes, in the smaller one over a distance of 11 myotomes.

I think we may conclude with fair accuracy that the egg of fig. 7 belongs to *Pellona ditchoa*.

WEBER and DE BEAUFORT, in their *Fishes of the Indo-Australian Archipelago II*, enumerate 11 species of *Pellona*. I have thus far had opportunity to count the vertebrae of a few of them only. For the others, however, we may provisionally draw certain conclusions from the numbers of scales along the lateral line. It appears that these numbers correspond to the resp. numbers of vertebrae. Thus, e.g., we found 50 vertebrae in *Pellona amblyuroptera*, and 45 in *Pellona ditchoa*. For the numbers of lateral line scales WEBER and DE BEAUFORT give 50 - 54 and 45 resp. For *Pellona elongata* I found  $21 - 22 + 28 - 29 = 50 - 51$  vertebrae, in *Pellona hoeveni* thrice  $18 + 24$  and once  $18 + 25 = 42 - 43$ . The number of lateral line scales in these two species is given as being 50 - 53 and 40 - 45 which also tallies fairly well.

The species of *Pellona* have been divided into two groups:

1° those with up to 45 scales in the lateral line:

<i>Pellona hoeveni</i>	Ll 40-45
„ <i>kampeni</i>	„ 44
„ <i>brachysoma</i>	„ 40-42
„ <i>ditchoa</i>	„ 45



2° those with about 50 scales in the lateral line:

<i>Pellona pristigastroides</i>	Ll 50
„ <i>amblyuroptera</i>	„ 50-54
„ <i>elongata</i>	„ 50-53
„ <i>dussumieri</i>	„ 48-50
„ <i>macrogaster</i>	„ 50
„ <i>xanthoptera</i>	„ 47-50
( „ <i>novacula</i>	„ 45-50) (once recorded by BLEEKER).

On the whole the latter group comprises the larger species (200 - 450 mm), the former group the smaller ones (less than 200 mm).

I now will describe a few more eggs which evidently belong to the genus *Pellona*.

In the Amphitrite Bay I found on January 18th, 1929, two eggs reminding one of the eggs of *Pellona elongata* and *amblyuroptera* but without any gelatinous coat, and with a bright yellow oil globule. The diameter of these eggs was 1.36 mm, that of the oil globule fully 0.3 mm. They hatched in the evening at 6.30 and 8.30 resp. and the examination of the larvae showed at once that I was dealing here with a *Pellona* egg. The larvae closely resemble those of *Pellona elongata* and *amblyuroptera*. The distribution of the black pigment spots e.g. is exactly the same: one on the head, one above the foremost myotomes and one round the gut near the anus. The yolk gradually tapers into the gut. The number of myotomes also tallies very well with what we have found in *Pellona*. I counted 32 myotomes in front of the anus.

In the newly hatched larva 15 tail myotomes could be counted, in the other, about 24 hours old, 10 - 12. Thus I think the most reliable numbers are  $32 + 10 - 12 = 42 - 44$ . Evidently we are dealing with the egg of one of the smaller *Pellona* species, with 40 - 45 vertebrae. I don't venture to suggest, however, which of these species it may be.

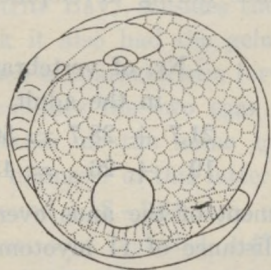


Fig. 11. Egg of *Pellona*  
sp.  $\times 26$ .

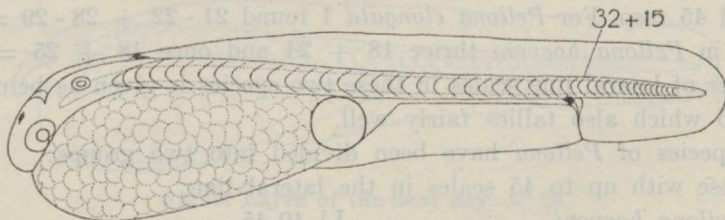


Fig. 12. Larva shortly after hatching,  $\times 26$ .

Finally I have to mention two more eggs which, I think, must be referred to the genus *Pellona* and evidently to two closely related species of this genus.



On June 22d, 1923, at  $1^{\circ}51\frac{1}{2}'$  S  $104^{\circ}32'$  E (east coast of Sumatra, near Berhala Strait), I found three samples of the first of these eggs. The diameter is 1.35 mm, and there is a gelatinous coat which, however, is narrower than in the eggs of *Pellona elongata*, *amblyuroptera* and *ditchoa*. The diameter of the egg together with the gelatinous coat amounted to 1.47 mm. At one place a micropyllic canal is seen to pierce the gelatinous coat. The segmented yolk contains one yellowish oil globule with a diameter of 0.3 mm.

The eggs hatched as early as 8 a.m. Fig. 14 shows a larva at 1.30 p.m. Black pigment spots are found, one at the anterior side of the eye and one above the foremost myotome. The yolk tapers backward into the gut, in this posterior part of the yolk the oil-globule is found again. The number of myotomes is  $34 + 10 = 44$ , which shows that we are dealing again with one of the species with 40 - 45 vertebrae.

A similar, though not identical, egg was found by me on November 19th, 1925, in Sunda Strait near Labuan (salinity 33.9 ‰), this time in one sample

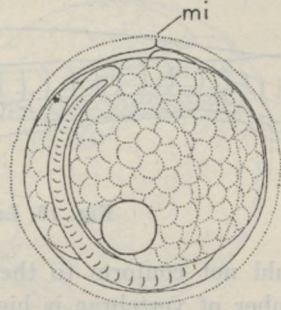


Fig. 13. Egg of *Pellona* sp.  $\times 26$  mi, micropyle.

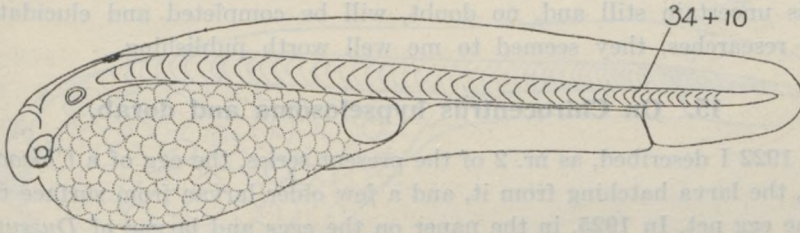


Fig. 14. Larva shortly after hatching,  $\times 26$ .

only. The diameter was 1.14 and the egg was surrounded by a similar thin gelatinous coat as the foregoing. The diameter of the egg together with the gelatinous coat amounted to 1.26 mm. A micropyllic canal was evident here again. The segmented yolk contained one colourless oil-globule of which the diameter, unfortunately, has not been determined but which, at any rate, was smaller than the oil-globule of the foregoing egg.

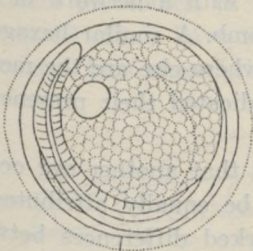


Fig. 15. Egg of *Pellona* sp.  $\times 26$ .

Fig. 15 was made after life at 2 p.m. The egg hatched late in the evening only. The larva shown in fig. 16 will be about  $1\frac{2}{3}$  days old, being fixed on November 19th, 1 p.m. It has no pigment. The yolk has been resorbed for a considerable part, the rest of the oil-globule is seen again in the posterior extremity. The number of myotomes was low:  $30 + 10 = 40$ .



One would be inclined, therefore, to think here in the first place of a species with such a low number of vertebrae as e.g. *Pellona brachysoma*. WEBER and DE BEAUFORT record this species a.o. from Padang and Priaman (West coast of Sumatra), so that it might be a more oceanic species, although this

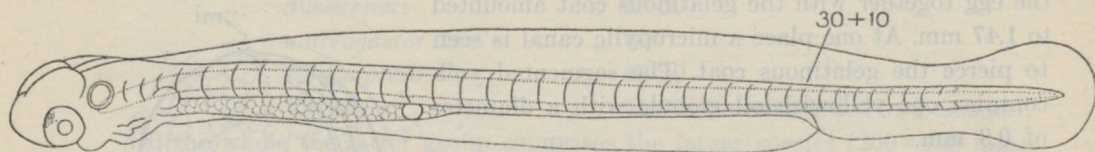


Fig. 16. Larva of the day after hatching,  $\times 26$ .

would not conform to the rule that in oceanic species of a given genus the number of vertebrae is higher than in those living in coastal waters. BLEEKER (Atlas Ichthyologique, Tome VI, p. 119), who has first described this species, says: „Le *brachysoma* doit être une espece fort rare, puisque je n'en ai eu sous les yeux que trois individus”, and mentions Batavia, Priaman and Singapore as places of origin. The high salinity of the water in which the egg was found suggests indeed a less neritic species.

This, then, are my results up to now as regards the genus *Pellona*. Although much is uncertain still and, no doubt, will be completed and elucidated by further researches, they seemed to me well worth publishing.

### 15. On *Chirocentrus hypselosoma* and *dorab*.

In 1922 I described, as nr. 2 of the present series, the egg of a *Chirocentrus* species, the larva hatching from it, and a few older larvae from surface catches with the egg net. In 1925, in the paper on the eggs and larvae of *Dussumieria*, I showed a still somewhat older larva of *Chirocentrus* caught with the egg-net.

The egg of the parang-parang (*Chirocentrus*) proved to be very easily recognizable, having a diameter of about 1,6 - 1,65 mm, a foamy yolk, as is characteristic for clupeoid eggs, a number of colourless oil-globules of moderate size and, finally, an egg-membrane covered with a network of fine ridges looking in stronger enlargement like a honey-comb. A similar hexagonal design is found in a few other pelagic eggs too, but nowhere else are the meshes so fine. As they are difficult to reproduce, I have indicated their presence in figs. 1 and 4 by a grey tinge.

During my further researches, now, I have found that another egg occurs in the Java Sea, and is not rare at all, which must be equally attributed to the genus *Chirocentrus*. Although there are very marked differences between these two kinds of eggs, they give rise to nearly identical larvae.

First we will consider the two varieties of eggs, which, for the sake of convenience, will be called *a* (the one described formerly) and *b* (the one to be described presently). The diameter of these two varieties is fairly the same, as a rule 1,6 - 1,65 mm. The variety *b* has a smooth egg membrane, without



hexagonal network. The foamy yolk contains only one small, colourless, oil-globule. As shown by fig. 2 it presents a close resemblance to the egg of *Dussumieria*. The diameter of the latter, however, is somewhat less: 1,45 - 1,55 mm.

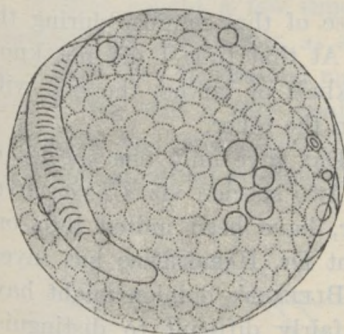


Fig. 1. The egg a,  $\times 26$ .

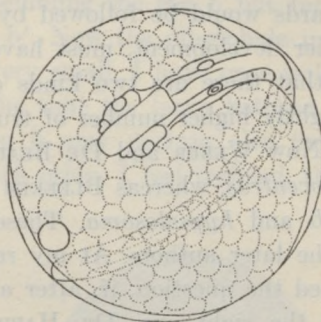


Fig. 2. The egg b,  $\times 26$ .

As mentioned above, the larvae hatching from the two kinds of eggs are practically identical. The number of myotomes in front of the anus, however, is slightly but constantly different. In the larva from the egg a we count 53 -

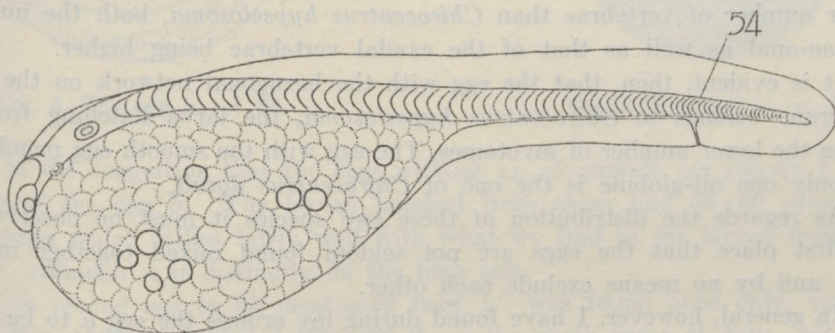


Fig. 3. Larva from the egg a,  $\times 26$ .

55 trunk myotomes, in the larva from the egg b this number amounts as a rule to 57 - 58. I have succeeded in rearing the larvae up to a stage of 3  $\times$  24 hours. This stage proved identical to the one reproduced in fig. 7 of my

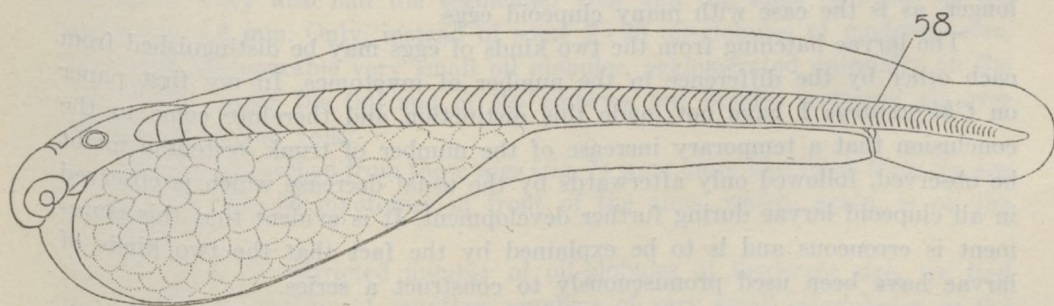


Fig. 4. Larva from the egg b,  $\times 26$ .



paper of 1922. It seems evident, then, that the latter larva, which was caught pelagically, does not belong to the egg *a* but to the egg *b*. My conclusion (Treubia Vol. III p. 42): „It appeared that in the next following stages a slight increase of the number of trunk myotomes was to be noticed”, which only afterwards would be followed by the usual decrease of that number during the further development, must have been erroneous. At that time I did not know yet that there are two kinds of eggs and two kinds of larvae, the one with a slightly higher number of trunk myotomes than the other.

NOW WEBER and DE BEAUFORT as well as DAY give only one species of *Chirocentrus*, whereas BLEEKER has distinguished two species, viz. *Chirocentrus dorab* and *hypselosoma*. These species, however, have been united into one by the later authors. At my request my assistant Dr. HARDENBERG has investigated the question, if, after all, in this matter BLEEKER's opinion might have been the right one. Dr. HARDENBERG found it fairly difficult to distinguish two species but finally has come to the conclusion that, indeed, two species must be assumed. This may be seen from his paper following the present one. At first sight, however, these two species are more difficult to distinguish than their eggs!

As pointed out by Dr. HARDENBERG, *Chirocentrus dorab* has a slightly higher number of vertebrae than *Chirocentrus hypselosoma*, both the number of prae-anal as well as that of the caudal vertebrae being higher.

It is evident, then, that the egg with the hexagonal network on the egg-membrane belongs to *Chirocentrus hypselosoma*, the larva hatching from it having the lower number of myotomes. The egg with the smooth egg membrane and only one oil-globule is the one of *Chirocentrus dorab*.

As regards the distribution of these two species it must be observed in the first place that the eggs are not seldom found mixed together in one catch and by no means exclude each other.

In general, however, I have found during my cruises the egg *a* to be more common along the north coast of Java, the egg *b* along the East coast of Sumatra. Both eggs are found at a certain distance from the coast, in water with a salinity varying between 28%, and 34%, and apparently most frequently near the mouths of rivers, although by no means restricted to these. Further from the coast, e.g. in the middle of the Java Sea, they are not found any longer, as is the case with many clupeoid eggs.

The larvae hatching from the two kinds of eggs may be distinguished from each other by the difference in the number of myotomes. In my first paper on *Chirocentrus* I have not made this distinction and therefore come to the conclusion that a temporary increase of the number of trunk vertebrae might be observed, followed only afterwards by the usual decrease which is observed in all clupeoid larvae during further development. It is evident that this statement is erroneous and is to be explained by the fact that the two kinds of larvae have been used promiscuously to construct a series.

I will finish this paper by describing two more varieties of *Chirocentrus*-



eggs, which may suggest the possibility that still more species or races of this genus could be distinguished, unless we consider them as accidental deviations from the types. In the latter case one of them is to be considered as a variety of the egg *a*, in the other of the egg *b*. I will, accordingly, call them *a'* and *b'*.

I have caught a few times eggs closely resembling the egg *b* but for the absence of an oil-globule, as shown in fig. 5 as *b'*. Now the oil-globule in the egg *b* may vary in size and may be sometimes very small. I have once isolated such an egg with a very small oil-globule. At the time the larva hatched, the oil-globule had disappeared! Sometimes the egg *b* may contain also two or three very small oil-globules situated close to each other. I feel inclined, there-

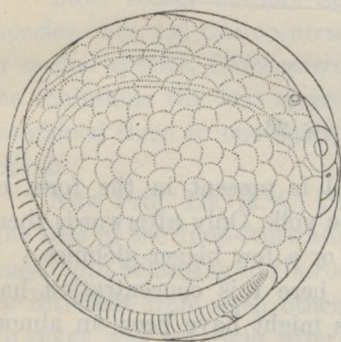


Fig. 5. The egg *b'*,  $\times 26$ .

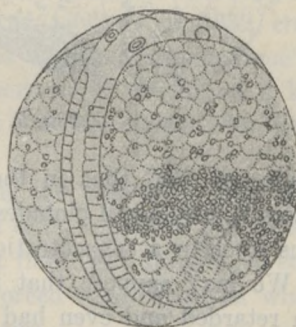


Fig. 6. The egg *a'*,  $\times 26$ .

fore, to the suggestion that the eggs without an oil-globule are merely a variation of the egg *b*. The larvae hatched from them had 58-60 prae-anal myotomes which tallies fairly well with what we find in the larvae from the egg *b*, although it is distinctly on the high side.

The second egg to be mentioned here, *a'*, was found once only, viz. on May 21st, 1928, at  $6^{\circ}9\frac{1}{2}'$  S  $108^{\circ}49'$  E, on the north coast of Java, opposite Cheribon, above a depth of 25 fathoms and outside a strongly developed *Trichodesmium*-zone. Salinity about 31.5 ‰.

Two eggs, quite alike, were caught here in a surface haul. They had the fine hexagonal meshwork on the egg membrane which is so characteristic for the egg *a*. They also had the segmented yolk and the same diameter as the egg *a*, viz. 1.6 mm. Only, instead of some 7-20 oil-globules of moderate size, there were innumerable very small oil globules, agglomerated especially on the ventral side under the tail end of the embryo, but besides scattered all over the surface of the yolk.

The larvae hatched from these eggs (fig. 7) were quite like those from the egg *a*. They had 55-56 myotomes in front of the anus, which, again, is on the high side.

Instead of a restricted number of oil-globules of moderate size, we find again an agglomeration of countless numbers of very small oil-globules on the



ventral side of the yolk and scattered oil-globules of the same size all over the surface of the yolk.

Are we dealing here with an accidental variation of the egg *a*? The fact that two eggs were found showing exactly the same characteristics seems not to support this supposition. On the other hand it is a matter of fact that, if we examine eggs from the ovaries of fishes having pelagic eggs with an oil-

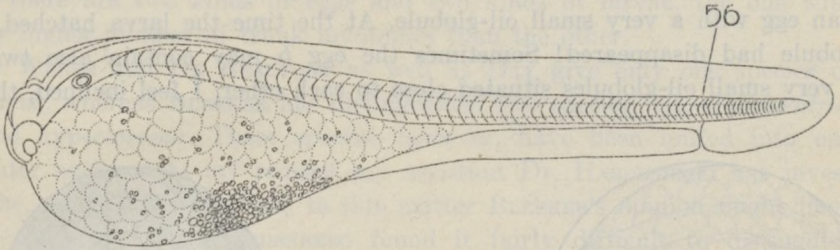


Fig. 7. Larva from the egg *a'*,  $\times 26$ .

globule, we find that in the ovarian eggs the oil is present in the form of numerous very small globules scattered all over the yolk. Only afterwards there seems to occur a concentration of the oil into one or a few bigger globules.

We may suppose that in the egg described here this concentration had been retarded and even had failed to occur. This might have been an abnormality occurring in all the eggs of one individual and the two eggs found by me might have been produced by this individual.

The question whether there are more races of *Chirocentrus*, as seems to be suggested also by Dr. HARDENBERG's results, or whether the two varieties of eggs described in the last part of this paper are more accidental deviations from the type, must provisionally remain unanswered. It is evident, however, that BLEEKER has rightly distinguished *two* species of the genus *Chirocentrus*.



## SOME REMARKS ON THE GENUS *CHIROCENTRUS* (CUV.)

by

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Most recent authors agree, that the genus *Chirocentrus* consists of one species only, i.e. *Chirocentrus dorab* FORSK. BLEEKER, however, in 1852, created a second species, *Chirocentrus hypselosoma*. In his "Atlas Ichthyologique" T.6 he maintains the two species, but all later authors have, as far as I know, combined them to one again, which, of course got the older name *Chirocentrus dorab*.

Now Prof. Dr. H. C. DELSMAN, while studying the planctonic fish eggs of the seas of the Indo-Australian Archipelago, found quite regularly two different eggs, both belonging to *Chirocentrus*. They were, at first sight already, so entirely different from each other, that the question forced itself upon us whether BLEEKER was not right after all with his two species.

At Dr. DELSMAN's request I have made a special study of this problem. It proved at first to be no easy matter to distinguish more than one species or race. Gradually, however, I succeeded in finding a few differences. These differences were slight ones, but they proved to be constant, and I think they afford sufficient reason, in combination with Dr. DELSMAN's results, to reestablish the two species of BLEEKER, as will be pointed out below.

Both species of *Chirocentrus* are long slender fishes of pelagic habits, which are named by the natives Parang-Parang or Golok-Golok (sword). They are said to attain a length of more than one metre, but specimens of more than 90 cm are very rare on the fishmarkets. (STEAD in his "Fishes of Australia" gives a length of more than 4 metres, which, as pointed out by Dr. DELSMAN, must be an erroneous statement).

They are voracious fishes with a good number of strong canine-like teeth in the jaws. The praemaxillary bone bears two very strong conical teeth pointing horizontally forward. These two teeth are covered by an upperlip which is automatically withdrawn when the mouth is opened. At the same time the two teeth separate from each other. The fore-end of the maxillary bears some little teeth which are followed behind by a few big ones. Towards the back part of the jaw they become more slender and gradually diminish in size. The mandibular bone bears 5 - 10 strong teeth, of which the third or fourth is always extraordinarily strong.

In the mouth we see a patch of little teeth on the palatines, the tongue is



teethless. The gill arches and copulae are wholly covered by small but strong teeth.

Young specimens possess more teeth than old ones which is especially the case with the teeth in the mandibulary.

The intestines are, in agreement with the carnivorous habits, very short. The stomach is a big blind sack with longitudinal folds in young specimens and irregular low ridges in older ones. It is as long as the whole abdomen and may often contain two or more undamaged fishes. I have found in the stomach of a specimen of 65 cm (without tail) a *Chirocentrus* of 24 cm that had been swallowed whole. The intestine itself is short and straight from the gullet to the anus. It contains a rudimentary spiral valve, as was noted by CUVIER. There are no pyloric appendages.

The fishes are mature, when they have reached a length of about 40 - 60 cm. In one individual of 60 cm (without tail) both ovaria together weighed 63.82 gr and contained about 160,000 eggs.

After spawning the ovarium is an empty bag, but soon young eggs can be seen regenerating from a strip of tissue along the mesovarium. How often they spawn during lifetime cannot yet be said. In a single sample of mature fishes one can find at any time ovaries in every stage of ripening.

As to the question, whether there are one or two species, the following remarks may be made.

I do not think it necessary to give here the full descriptions of the two species, as BLEEKER has done that already. As there are of course many points in which they agree, I think it better to lay stress upon the differences.

BLEEKER himself evidently found it rather difficult to distinguish the two species. In his Atlas, after the descriptions, he writes as follows:

„Sur deux individus d'une longueur de 442'' ces differences se traduisent comme suit.

*Chirocentrus dorab*. Hauteur du corps 7 fois dans sa longueur sans la caudale. Hauteur de la tête  $1\frac{2}{3}$  fois dans sa longueur sans la mâchoire inférieure. Hauteur de la queue près de la base de la caudale 3 fois dans la distance entre la dorsale et la caudale. Tête 6 fois dans la longueur du corps sans la caudale. Ecaillés visiblement plus petites que dans l'*hypselosoma*.

*Chirocentrus hypselosoma*. Hauteur du corps  $5\frac{1}{2}$  fois dans sa longueur sans la caudale. Hauteur de la tête  $1\frac{1}{3}$  fois dans sa longueur sans la mâchoire inférieure. Hauteur de la queue près de la base de la caudale  $2\frac{1}{3}$  fois dans la distance entre la dorsale et la caudale. Tête  $5\frac{2}{3}$  fois dans la longueur du corps sans la caudale. Ecaillés visiblement plus grandes que dans le *dorab*."

From these descriptions it follows that *Ch. dorab* is the more slender species. This tallies with the fact that *Ch. dorab*, as will be pointed out below, has from two to four vertebrae more than *hypselosoma*. In agreement with the more slender body *Ch. dorab* has a head which is not as high as that of *hypselosoma* (cf. below).



I have studied the following characteristics considered by BLEEKER already <sup>1)</sup> and have added a few of my own.

#### LENGTH: HEIGHT.

According to BLEEKER this is  $5\frac{1}{2}$  for *hypselosoma* and 7 for *dorab*. In Table nr. I I give some measurements of my own.

In this and the following tables I have taken one sample of *Chirocentrus dorab* from Batavia consisting of fishes of about 40 cm. I took three samples of *hypselosoma* (Bagan I, Bagan II, Batavia), of different size. The sample Bagan I was collected at Bagan-si-Api-Api (Sumatra) in January 1929 and consists equally of fishes of about 40 cm. Bagan II was collected at Bagan in October 1929 and contains young fishes of about 10-20 cm. The *hypselosoma* sample from Batavia has very big fishes of about 60-80 cm. I have chosen these three different samples in order to see if there were differences in the measurements due to size (age). As the specimens of my sample of what I call *dorab* are all the same size (40 cm), I could not give three different sizes for this species too. I have computed all quotients up to one decimal.

Table I. Length : Height.

Quotients	N	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
<i>Ch. dorab</i> . . . Batavia	34								1	1					1			2			3		5	3	2	1	3	3	3	2			2	2
<i>Ch. hypselosoma</i> Bagan I	36						2	4	1	6	4	4	6	1	3	1		2	1	1														
<i>Ch. hypselosoma</i> Bagan II	27		1		4	2	2	2	4	3	4	3	1		1																			
<i>Ch. hypselosoma</i> Batavia	37		4	2	1	1	2	6	3	4	4	5	1	1		1	1						1											

As we see in Table nr. I the range of the quotients for *Chirocentrus dorab* is from 5.6 to 8.1 with the maximum between 7.0 and 7.7. For *hypselosoma* the range is from 5.0 to 7.0 with the maximum between 5.0 to 6.0. The difference between *dorab* and *hypselosoma* is very evident, although it is not always possible to say to which species each single fish belongs, if we consider this characteristic only.

After multiplying the quotient with 10, to avoid superfluous decimals, we find for *dorab* the average  $71.70 \pm 1.01$  (standard error). The average for *hypselosoma* of the same size (Bagan I) is  $55.67 \pm 0.56$ . The difference is  $16.03 \pm \sqrt{1.01^2 + 0.56^2} = 16.03 \pm 1.15$ . As 16.03 is much more than three times 1.15 we have a real and very evident difference between *dorab* and *hypselosoma* <sup>2)</sup>).

<sup>1)</sup> Following closely the methods of BLEEKER.

<sup>2)</sup> I compared only the *hypselosoma* sample Bagan I with *dorab*, the others being of different size.



The average for Bagan II is  $59.09 \pm 0.54$ . The difference between the samples Bagan I and Bagan II is  $3.52 \pm 0.77$  and is a real one. This is due perhaps to the different size (age). The average for *hypselosoma* from Batavia is  $56.44 \pm 0.68$ . The difference between this and the sample Bagan II is  $3.65 \pm 0.86$ , a real one too and possibly due to size. When comparing Batavia with Bagan I (both consisting of adult fishes though of different size) the difference is  $0.77 \pm 0.87$  and thus there is no true difference between them. Therefore the difference between the two samples of adult fishes on the one side and the collection of young fishes from Bagan on the other side (Bagan II) is probably due to the difference in size only. Later on, indeed, we still see that in dealing with *Ch. hypselosoma* we will have to take account of the possibility of racial differences also.

#### LENGTH OF THE HEAD: HEIGHT OF THE HEAD.

According to BLEEKER the quotient for *dorab* is 1.6 - 1.7 and for *hypselosoma* 1.3 - 1.4 (see Table nr. II).

Tablê II. Length of the head : Height of the head.

Quotients	N	12	13	14	15	16	17	18
<i>Ch. dorab</i> . . . . . Batavia	34		1	2	8	19	4	
<i>Ch. hypselosoma</i> . . . . . Bagan I	36		1	10	17	6	2	
<i>Ch. hypselosoma</i> . . . . . Bagan II	27			3	20	4		
<i>Ch. hypselosoma</i> . . . . . Batavia	37		8	23	5	1		

My figures for *dorab* are about the same as those given by BLEEKER. For *hypselosoma* I find for the first two samples slightly more.

The average for *dorab* is  $15.68 \pm 0.14$  and for *hypselosoma* of the same size (Bagan I)  $14.95 \pm 0.16$ . The difference is  $0.73 \pm \sqrt{0.14^2 + 0.16^2} = 0.73 \pm 0.21$ . As 0.73 is more than three times 0.21, the difference between *dorab* and *hypselosoma* of equal size is real.

Now, if we compare the three samples of *Ch. hypselosoma* mutually we find as follows.

The average for the sample Bagan II is  $15.03 \pm 0.11$ . Calculation shows that there is no real difference between Bagan I and Bagan II. For the big *Ch. hypselosoma* from Batavia we find the average  $13.98 \pm 0.11$ . If we compare this with Bagan I and Bagan II we find  $0.97 \pm 0.19$  and  $1.05 \pm 0.15$  resp., and thus a real difference. Whether this is due to size only or to the samples belonging to two races of the same species we cannot say yet. I had from Batavia only two specimens of *hypselosoma* of 20 cm (not given in the table). As these



have both the quotient 1.5 (like Bagan I and Bagan II) the difference found may be due to size only.

DISTANCE CAUDALIS-DORSALIS: HEIGHT OF CAUDAL PEDUNCLE.

According to BLEEKER the quotients are 3.0 for *dorab* and 2.3 - 2.4 for *hypselosoma*. (see Table III).

Table III. Distance caudalis-dorsalis : Height of caudal peduncle.

Quotient	N	20	21	22	23	24	25	26	27	28	29	30	31
<i>Ch. dorab</i> . . . . . Batavia	34					3		5	6	5	8	6	1
<i>Ch. hypselosoma</i> . . . . Bagan I	36				4	8	6	7	6	3	1	1	
<i>Ch. hypselosoma</i> . . . . Bagan II	27	1	3	8	10	2	3						
<i>Ch. hypselosoma</i> . . . . Batavia	37				7	16	7	5	2				

As the average for *Ch. dorab* is  $27.86 \pm 0.35$ , for *hypselosoma* (Bagan I)  $25.86 \pm 0.25$  the difference is  $2 \pm 0.43$ , which is a real one.

For the small *hypselosoma*'s (Bagan II) the average is  $22.67 \pm 0.23$ . As difference between the two samples from Bagan we find  $3.19 \pm 0.33$ . This difference, therefore, is real and according to what we found before, probably due to size.

The average for Batavia is  $24.42 \pm 0.18$ . Comparing this with the sample Bagan II the difference is  $1.75 \pm 0.29$ , and thus again a real one. When comparing with Bagan I the difference is  $1.44 \pm 0.30$ , which is also a true one.

Judging from these three differences, we can hardly avoid concluding that there is a difference due to size (age) as well as to race. For if the difference were due to size only the average from Batavia would be higher than that for Bagan I. The *hypselosoma* from Batavia seems to belong to another race as the *hypselosoma* from Bagan (cf. also what is said on the influence of sex below).

Table nr. III shows that when considering this characteristic, we find a difference between *dorab* and *hypselosoma*. A difference, however, which again does not enable us to recognize each single specimen at hand.

LENGTH OF BODY: LENGTH OF THE HEAD.

This quotient is, according to BLEEKER, for *dorab* 6.0 and for *hypselosoma* 5.6 - 5.7 (see Table nr. IV).

The average for *Ch. dorab* is  $58.30 \pm 0.33$ . The average for *hypselosoma* of Bagan I is  $52.84 \pm 0.31$ . The difference is  $5.46 \pm 0.45$ , a true one. In both cases my figures are somewhat lower than those found by BLEEKER.



Table IV. Length of Body: Length of Head.

Quotient	N	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
<i>Ch. dorab</i> . . . . . Batavia	34									1		1	3	7	6	6	8	1			1
<i>Ch. hypselosoma</i> . . . Bagan I	36						3	9	5	6	3	8	1	1							
<i>Ch. hypselosoma</i> . . . Bagan II	27			1		4	9	4	4	3	2										
<i>Ch. hypselosoma</i> . . . Batavia	37									1	1	6	8	11	5	1	2	1			1

The average for *hypselosoma* of Bagan II is  $50.81 \pm 0.31$ . The difference with the sample Bagan I is  $2.03 \pm 0.43$ , a true one.

The average for *hypselosoma* from Batavia is  $56.90 \pm 0.30$ . The difference with Bagan II is  $6.09 \pm 0.43$  and with Bagan I  $4.06 \pm 0.43$ , in both cases a real one. We see from this that some of the differences must be due to age. The young fishes from Bagan II have the lowest average, next comes the average of Bagan I and after that the big fishes of Batavia.

Whether the big average of the Batavia sample is due to the bigger size only or partly to race characters also, we cannot conclude yet from these figures.

#### SCALES.

The scales are very deciduous and it is difficult to find a specimen on the market with any scale left on it. The scale pouches are often difficult to distinguish (as big patches of the skin are flattened in preserved fishes). This renders it difficult to count their number on the linea lateralis and transversalis. As a fact no author mentions them in his description. The scales, if normal, are oval and finely striated in transverse direction. In many scales the striae are irregular, and it is sometimes difficult to find a normal one. They seem to be exposed to many injuries.

BLEEKER says *hypselosoma* has the biggest scales. I found on the contrary, that this is the case with *dorab*. I suppose this must be a mistake of the author. I considered only the scale pouches as I had no opportunity to compare the scales of two individuals of the same size of both species.

The number of scales in the transversalis near the dorsal fin (between the linea lateralis and the back) amounts for *dorab* to about 20 and for *hypselosoma* to about 25.

It was impossible for me to count the scales along the linea lateralis.

#### FIN FORMULAE.

BLEEKER gives the following figures for the fin formulae:

*Ch. dorab* D. 4/12 - 4/13 P. 1/12 - 1/13 V. 1/6 A. 1/27 - 4/32 C. 1/15/1.

*Ch. hyp.* D. 4/12 - 4/13 P. 1/11 - 1/13 V. 1/5 - 1/6 A. 1/25 - 3/30 C. 1/17/1.



My figures for the *P. dorsalis* are the same as given by BLEEKER for the two species. In a very few cases only I found 3 unbranching rays.

In examining the pectorals I found some difference. Counting the fin rays of 30 *Ch. dorab* I got 4 times 1/12, 25 times 1/13 and 1 time 1/14, being about the same as what BLEEKER found.

In 30 *Ch. hypselosoma* I counted 10 times 1/13 and 20 times 1/14, being somewhat more than BLEEKER found. Thus there is evidently some difference between *hypselosoma* and *dorab*, although again not sufficient to distinguish each single specimen by it.

About the ventrals I have no remarks, my figures being the same as those of BLEEKER.

Counting the rays of the anal fin I found for *Ch. dorab* the same figures as BLEEKER, but for *hypselosoma* 4/28-32, being about the same as in *dorab*.

I do not know what made BLEEKER write down 1/25 - 1/30. Of course it may be possible that there exists somewhere a race with a different number of fin rays, but it may be a mistake also.

BLEEKER gave a difference of 2 rays between the two species for the *P. caudalis*. I counted always 1/17/1 and sometimes 1/16/1 in both. His statement 1/15/1 for *dorab* is probably wrong.

#### GILL-RAKERS.

The gill-arches bear some strong, flattened, spinulated gill-rakers. I found their number to be a very good characteristic to distinguish the two species.

Deviating from the ordinary practice I counted all the gill-rakers on the whole gill-arch. The first number is that of the upper half, the second of the lower half.

For *Ch. dorab* I found on the upper half mostly 3. Out of 77 cases I found 5 times 2, 6 times 4 and 66 times 3 gill-rakers. On the lower half the numbers ranged from 17 - 13, being 1 time 17, 8 times 16, 31 times 15, 26 times 14 and 11 times 13. (see Table nr. V).

Table V. *Ch. dorab*. Number of Gill-Rakers.

	Upper half			Lower half				
Number of gill-rakers . . . .	2	3	4	13	14	15	16	17
Number of cases . . . . .	5	66	6	11	26	31	8	1

For *Ch. hypselosoma* the matter is somewhat more complicated as very large specimens seem to loose part of their gill-rakers. At least in big fishes there are gaps between the gill-rakers where scars may be seen. This will probably be the case with *dorab* too, but I do not possess a specimen bigger than about 40 cm and up to that range *hypselosoma* specimens are behaving normally.



The upper half of the gill-arch of *hypselosoma* bears 5 gill-rakers (the number ranging from 4 - 6, but far the greater part of the specimens having 5).

Taking into consideration 83 specimens under 50 cm., I found 19 times 4, 65 times 5 and 4 times 6 gill-rakers. (see Table nr. VI). In bigger specimens I found from 3 to 2 gill-rakers, but when counting the scars also, their number rose to 5 and 6.

Table VI. *Ch. hypselosoma*. Number of Gill-Rakers.

	Upper half			Lower half					
Number of gill-rakers.	4	5	6	14	15	16	17	18	19
Number of cases . . .	19	65	4	8	5	20	34	14	2

On the lower half of the gill-arch I noticed in the same 83 animals 14 - 19 gill-rakers, respectively 8, 5, 20, 34, 14, and 2 times. .

In big ones I counted numbers from 8 to 12 without scars and 16 - 17 the scars included.

This characteristic is an easy one to distinguish the two species by. The commonest numbers for *dorab* being 3 - 14/15 and for *hypselosoma* 5 - 16/17. The real numbers are only slightly overlapping each other.

#### LENGTH OF THE UPPER JAW.

Another very good characteristic, by which to distinguish the two species, if the specimens are not too small, is the length of the upper jaw. Specimens of *hypselosoma* have the maxillary reaching to over the praeoperculum, while specimens of *dorab* have some distance left between the praeoperculum and the end of the jaw.

This is a very important characteristic that always holds good. Only in very young fishes, as for instance those from the sample Bagan II, both species have the jaw of the same length, not reaching the praeoperculum. But the older ones are always to be recognized by it at first glance.

#### NUMBER OF VERTEBRAE.

Considering the number of vertebrae we find also some difference between the two species.

First I will mention the numbers I found for *Ch. dorab*. I used samples from Singapore, from Batavia (western part of Java), from Cheribon, in the middle part, and from Toeban, in the eastern part of Java. For the praecaual vertebrae I got the following numbers (see Table nr. VII).

When calculating the differences we find that there is no real one between the samples from Singapore and Batavia, and between those of Cheribon and Toeban. But if we compare Cheribon and Batavia we find  $0.89 \pm 0.33$ , and



Table VII. *Ch. dorab*. Praecaual Vertebrae.

Locality	Vertebrae					N	Average	Standard error
	42	43	44	45	46			
Singapore. . . . .	2	6	3	8		19	43.89	$\pm 0.24$
Batavia. . . . .	3	11	16	4		34	43.61	$\pm 0.13$
Cheribon . . . . .			4	1	1	6	44.50	$\pm 0.31$
Toeбан. . . . .		4	8	6		18	44.11	$\pm 0.17$

Toeбан and Batavia  $0.50 \pm 0.21$ . Therefore there are some indications, but no certainty, that the specimens from Cheribon and Toeбан belong to another race.

Something similar is found in other Clupeid genera also (investigations not published yet). In the clear water with higher salinity of the eastern part of Java sea there seem to live other races with a higher number of vertebrae than in the western half.

Now *Chirocentrus* is a fish not living in shoals and nothing is known about their migrations, if there are any. Therefore we have no proof that two specimens caught at the same place always belong to one and the same race. Mixed catches may occur. Only with material much larger than mine this problem can definitely be solved.

The caudal vertebrae are dealt with in Table nr. VIII. In their numbers the hypural is included.

Table VIII. *Ch. dorab*. Caudal Vertebrae.

Locality	Vertebrae					N	Average	Standard error
	28	29	30	31	32			
Singapore. . . . .		6	8	4	1	19	30.00	$\pm 0.19$
Batavia. . . . .	1	4	22	3	4	34	30.14	$\pm 0.15$
Cheribon . . . . .	1	2	2	1		6	29.50	$\pm 0.39$
Toeбан. . . . .	2	5	10	1		18	29.55	$\pm 0.18$

Calculating the differences shows us that there are hardly any between the four samples.

In Table nr. IX the total number of vertebrae are given.

The differences found in Table nr. IX are not sufficient to allow any conclusion.

The numbers in Tables nr. VIII and nr. IX do not give support to the admittance of different races as suggested by table nr. VII. Therefore I think



Table IX. *Ch. dorab*. Total Number of Vertebrae.

Locality	Vertebrae				N.	Average	Standard error
	72	73	74	75			
Singapore . . . . .		4	13	2	19	73.89	$\pm 0.12$
Batavia . . . . .	2	10	16	6	34	73.76	$\pm 0.13$
Cheribon . . . . .		1	4	1	6	74.00	$\pm 0.23$
Toeban . . . . .	1	7	8	2	18	73.72	$\pm 0.19$

it better to assume for the present that there are no different races in *Ch. dorab*, the indications at hand being insufficient.

The three following tables deal with *Ch. hypselosoma*. I got samples from Bagan-si-Api-Api (Strait Malacca), Singapore, mouth of the Palembang river, mouth of the Panei river (north of Bagan) and Batavia. From Bagan-si-Api-Api I got two samples (see above), also from Singapore. I bought at the fishmarket of Singapore two different samples, one containing fishes of about 60 cm and the other of about 40 cm which proved to be different.

In Table nr. X the number of the praecaual vertebrae is given.

Table X. *Ch. hypselosoma*. Praecaual Vertebrae.

Locality	Vertebrae							N	Average	Standard error
	39	40	41	42	43	44	45			
Panei river . . . . .				1	2	1		4	43.00	$\pm 0.35$
Bagan I. . . . .			10	18	8			36	41.95	$\pm 0.11$
Bagan II . . . . .	1		8	13	3	2		27	41.85	$\pm 0.19$
Singapore (big) . . .					5	7		12	43.58	$\pm 0.14$
Singapore (medium) .			4	6	1	1		12	41.91	$\pm 0.24$
Palembang river . .				3	3	3		9	43.00	$\pm 0.27$
Batavia . . . . .				1	19	16	1	37	43.45	$\pm 0.09$

From this table we see that the samples Bagan I and II show no difference. One of the Singapore samples seems to belong to the same group. In the same way the other sample from Singapore (big size) and the one from Batavia belong together as there is hardly any difference between them.

Only the small collections from the mouth of the Palembang and Panei rivers are somewhat different from the Singapore-Batavia group, but this difference is not sufficient to conclude with certainty that they belong to another race. This we may say that there are most probably two different races to be distinguished here, a result we have found also when comparing the relation between the distance caudalis-dorsalis and the height of the caudal peduncle.

Table nr. XI gives the number of caudal vertebrae.



Table XI. *Ch. hypselosoma*. Caudal Vertebrae.

Locality	Vertebrae					N	Average	Standard error
	26	27	28	29	30			
Panei river . . . . .			3	1		4	28.25	± 0.21
Bagan I . . . . .	1	3	17	15		36	28.08	± 0.13
Bagan II. . . . .		3	11	12	1	27	28.40	± 0.14
Singapore (big) . . .		1	8	3		12	28.16	± 0.15
Singapore (medium)		2	3	6	1	12	28.50	± 0.25
Palembang river . . .		1	3	5		9	28.44	± 0.23
Batavia . . . . .		5	17	14	1	37	28.29	± 0.12

The averages are all about the same. Real differences are not to be found.

The total numbers give again some evidence of the existence of different races, as will be shown in Table nr. XII.

Table XII. *Ch. hypselosoma*. Total Number of Vertebrae.

Locality	Vertebrae							N	Average	Standard error
	67	68	69	70	71	72	73			
Panei river . . . . .				1	1	2		4	71.25	± 0.42
Bagan I . . . . .		2	3	21	6	4		36	70.19	± 0.16
Bagan II . . . . .	1		4	12	6	4		27	70.25	± 0.12
Singapore (big) . . .					4	7	1	12	71.75	± 0.17
Singapore (medium) .			2	5	4		1	12	70.41	± 0.30
Palembang river . . .					5	4		9	71.44	± 0.16
Batavia . . . . .			1		10	21	5	37	71.78	± 0.12

In Table nr. XII we see again that the samples Bagan I and Bagan II and Singapore (medium size) belong to one group and Singapore (big size) and Batavia to another group. Further investigations will have to settle this question, whether the different samples in one group belong to one or more races. As shown in Table nr. XII the small samples from the Panei and Palembang rivers are intermediate again between the two groups; I do not know yet what this means. Perhaps a future publication may clear up this problem.

As will be seen at a glance when comparing the Tables nrs. X, XI, XII and the Tables nrs. VII, VIII and IX, there exists a big difference in the number of praecaual and caudal vertebrae as well as in the totals in *Ch. dorab* and *hypselosoma*.

From all the foregoing considerations it is evident that BLEEKER was right in distinguishing two species of *Chirocentrus* of which the eggs have been described by Dr. DELSMAN. There are indications that each of these two species consists of a number of local races but the evidence at hand is not sufficient



to settle this question definitely. An additional difficulty in solving this problem is afforded by what follows.

#### SEX RATES.

Examining the *hypselosoma*'s from Batavia I noticed a very peculiar fact. They were all of the feminine sex. Out of 37 I got one male only of 47 cm (tail excluded), the smallest of the whole sample. As this fact struck me I counted males and females in other samples too. The results are given in Table nr. XIII.

Table XIII. *Ch. hypselosoma*. Numbers of females and males.

Locality	♀	♂	Remarks
Panei river . . . . .	3	1	
Bagan I. . . . .	6	30	size 30-40 cm.
Bagan II. . . . .	—	—	fishes too young to determine the sex.
Singapore (big) . . . . .	12		size up to 60-70 cm.
Singapore (medium) . . . . .	1	11	size about 40 cm.
Palembang river . . . . .	7	2	the fishes from 30-60 cm. The two ♂♂ resp. 32 and 33 cm.
Batavia . . . . .	36	1	the smallest one.

From this table we see that in the different samples there are either considerably more ♀♀ or more ♂♂. In the samples containing fishes of big size (Singapore, Palembang river and Batavia) there are more females. The males belong mostly to the samples with smaller specimens.

This is very interesting for two reasons.

In the first place the samples containing mostly females or males agree with those samples in Tables nr. X, XI and XII which have a higher or lower number of vertebrae. For this reason it is possible that the assumed race differences given above are partly due to sex only. (cf. Lo GIUDICE "Sulle diverse razze locali o 'Famiglie' (Heincke) di acciughe" Rivista mensile di Pesca e Idrobiologica 1911).

But on the other hand there is the curious fact to be noticed, that in some localities there are practically females only and that in other the males have by far the majority.

In the vicinity of Batavia it is possible that only the big females are caught, assuming that *Chirocentrus* has dwarf males. The fishes are caught with big gillnets and the smaller males may escape. In this way we may get unreliable figures. I do not know by which means my Singapore specimens have been caught and thus it is possible that in assorting them the smaller males were separated from the bigger females. But this is certainly not the case with the specimens from Bagan-si-Api-Api, which are caught in fish traps



that do not give an opportunity to escape even to the smallest fry. One should therefore expect here about as many males as females.

I cannot give a satisfactory explanation of the facts mentioned above. Perhaps further investigations will contribute to solve this question.

I think, we are justified in assuming that the males of *hypselosoma* are smaller than the females. So the samples Bagan I and Singapore (medium size) contain most males. In the sample from the Palembang river the two smallest specimens are males and the same may be seen in the collection from Batavia as in the big sized specimens from Singapore.

The numbers for *Ch. dorab* are given in Table nr. XIV.

Table XIV. *Ch. dorab*. Numbers of males and females.

Locality	♂	♀	Remarks
Singapore . . . . .	43	6	
Batavia . . . . .	18	16	
Cheribon . . . . .	4	2	
Toeban . . . . .	15	3	

Nothing can be concluded with certainty from the data given above. There are perhaps more males than females. As all fishes are of the same size I cannot make out if in *dorab* the males are the smallest as well.

#### DISTRIBUTION.

About the distribution of the two species there is still much to be elucidated. They exclude each other by no means. In a single catch specimens of *dorab* as well as of *hypselosoma* may be found. Yet in the waters of relatively low salinity in the neighbourhood of Bagan-si-API-API and the mouth of the Panei river I have found during my two visits (January and October 1929) the species of *hypselosoma* only. In Singapore the two species are to be found and in the mouth of the Palembang river too. I got from there a sample of 10 specimens including 9 *hypselosoma* and 1 *dorab*. In Batavia the two species are found, *dorab* near the coast and *hypselosoma* at some distance from it. One should expect the contrary, as *hypselosoma* is found in the brackish to salt waters of Bagan-si-API-API. But, as pointed out above, there is evidence that they belong to different races. In the neighbourhood of Batavia the *dorab* is mostly immature, *hypselosoma* is quite full grown and the fishes are mostly very large, up to 90 cm. I never saw a *dorab* as big as that. The young individuals of *hypselosoma* seem to live far away from the coast too, as a thorough search at the fishmarkets of Batavia in the catches of the coastfishermen yielded two young ones only. I have examined some hundreds of smaller *Chirocentrus*, but all belonged to *dorab*.



As a matter of fact only six month ago it was not known to me that *hypselosoma* occurred in the Java sea. They are caught by the gillnets only which Japanese fishermen introduced quite recently.

I have not found *hypselosoma* east of Batavia, but BLEEKER mentions them, as far as the Moluccas. I once got a *Chirocentrus* in Toeban, which unfortunately was lost afterwards. It had a total number of vertebrae of 67. Judging from this it may have been *hypselosoma*. At that time I had not yet studied the differences between the two species. Thus I do not know with certainty to which species it belonged.

As a matter of fact I think it very probable that *hypselosoma* will be found along the whole north coast of Java, if the right kind of fishing gear is used. This opinion is supported by Dr. DELSMAN's results concerning the distribution of the two kinds of eggs.

### SUMMARY.

The genus *Chirocentrus* consists of two species, *Chirocentrus dorab* FORSK. and *Chirocentrus hypselosoma* BLEEKER.

The differences between the two species are:

- a. a statistical difference in the relation length : height.
- b. a statistical difference in the relation length of the head : height of the head.
- c. a statistical difference between the relation distance caudalis-dorsalis : height of caudal peduncle.
- d. a statistical difference in the relation length of body : length of head
- e. *Ch. dorab* has the bigger scales of the two.
- f. *Ch. dorab* has mostly one ray more in the pectoral fin than has *hypselosoma*.
- g. the gill rakers number for *dorab* mostly 3/15-14 and for *hypselosoma* 5/16-17.
- h. *Ch. dorab* has the heigher number of vertebrae (about 2-4) of the two.
- i. the *Ch. hypselosoma* specimens have the maxillary reaching to over the praecoperculum while specimens of *dorab* have some distance left between the latter and the end of the jaw.

From the figures given, especially from those of the vertebrae, the conclusion may be drawn, that there are perhaps some differences between the samples of *Ch. dorab*.

Between those of *Ch. hypselosoma* there are real ones, partly due to size (age), partly due to race. Racial characters which perhaps might prove to be sex differences only, as in the samples from different localities either the number of males or females predominates.

There is evidence that the males of *Ch. hypselosoma* are much smaller than the females.



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These authors have very kindly provided us with such material as they had from the area. The Indian Museum, the British Museum, the Philosophical Academy of Natural Sciences, and the United States National Museum have kindly made available to us certain specimens for examination with their great consideration.

Dr. C. F. Wu of Tsingling University and Mr. Li Ku Yuen of the National Union Medical College have very kindly made it possible for the illustrations in this paper. Dr. W. Anwar and Dr. R. Sankaran have also kindly given their manuscript in its preliminary stage. Miss E. R. Howland has written and checked the entire manuscript. We wish to express our thanks to all of them who have so kindly assisted us in this work.

In any study of this native fishy resources of the Philippines, it is one of these we have been able to answer satisfactorily. However, it is necessary for further investigation and additional material to be obtained. It is hoped that we can go back to a study of some of these important resources in the near future.

*Spongilla alba* (Cuvier, 1805)

## Historical Introduction

*Spongilla alba* was first described by Cuvier in the Bulletin of the Société de l'Atlantique Vol. 2, p. 22, pl. 1, fig. 2. It was later described and illustrated by







## NOTES ON THE FRESH-WATER SPONGES FROM THE DUTCH EAST INDIES

### II. Descriptions

By

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(The Rockefeller Foundation, Peking)

In a previous article published in "Treubia" Vol. XI, 2 (November 1929) we gave a historical statement of the work which has been done upon the fresh-water sponges of the Dutch East Indies up to the present time. In the present article it is our wish to make available for students of this group the results of our study of the materials representing the several recorded species which have been available and also to provide from other sources descriptions and illustrations of those species of which specimens could not be secured for a study at first hand.

In this work we have received the very courteous cooperation of Dr. K. W. DAMMERMAN who kindly arranged for the collections of the sponges to be made, and of Miss A. G. VORSTMAN who did most of the actual collecting of the specimens. The authorities of the Amsterdam Museum and Dr. W. ARNDT of the Berlin Zoological Museum have very kindly provided us with such material as they had from this area. The Indian Museum, the British Museum, the Philadelphia Academy of National Sciences, and the United States National Museum have kindly made available for us certain materials for comparison with those under consideration.

Dr. C. F. WU of Yenching University and Mr. LI KAI YUEN of the Peiping Union Medical College have very kindly made or arranged the illustrations for this paper. Dr. W. ARNDT and Dr. K. SCHRÖDER have also kindly gone over the manuscript in its preliminary stages. Miss E. R. ROBINSON has carefully read and checked the entire manuscript. We wish to express our thanks to all of these who have so kindly assisted us in this work.

In any study of this nature many questions will naturally arise. Most of these we have been able to answer satisfactorily; some few of them will need further investigation and additional material or literature. We hope to be able to come back to a study of some of these unanswered questions at some later date.

#### ***Spongilla alba* CARTER, 1849.**

##### Historical Statement.

*Spongilla alba* was first described by CARTER in the Journal of the Bombay Asiatic Society Vol. 3, p. 32, pl. 1, fig. 4, and in the Annals and Magazine of



Natural History, London, Vol. 4, p. 83, pl. 3, fig. 4, in the year 1849. KONINGSBERGER in Java Zool. Biol. p. 407, 1915 adds this (?) species to the fresh-water sponge fauna of Java. We have not been able to secure this reference and cannot give the exact locality from which it was collected. There also seems to be some doubt concerning the identification of the sponge. We will add the

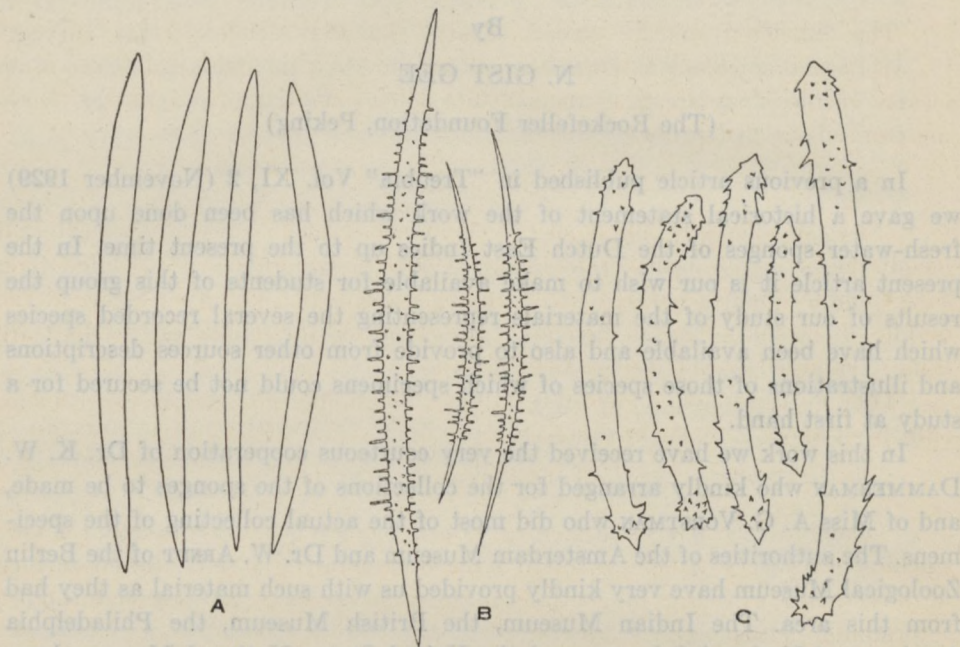


Fig. 1. *Spongilla alba* showing:

- a. Skeleton spicules
- b. Flesh spicules
- c. Gemmule spicules

following description of this sponge from ANNANDALE's Fauna of British India p. 76, 1911, for the convenience of those students who may wish to check up on the sponges of this region.

#### Habitat.

"The typical form of the species is usually found growing on rocks or bricks at the edges of ponds."

#### General Characteristics.

This sponge forms "masses of considerable area but never of more than moderate depth or thickness, surface smooth and undulating or with irregular conical projections". "Sponge hard, but brittle; oscula of moderate or large size, never very conspicuous; radiating furrows absent or very short; external membrane adhering to the substance of the sponge."

#### Color.

The "color is white or whitish."



### Structure.

"Skeleton forming a moderately dense network of slender radiating and transverse fibers feebly held together; little spongin present; the meshes much smaller than in *S. lacustris* or *S. proliferens*."

### Skeleton Spicules.

The "Skeleton spicules smooth, sharply-pointed, slender, feebly curved." Abnormal spicules are not infrequently found and the axial canals are often clearly visible. They are from about 280 to 340  $\mu$  long and have diameters varying from about 14 to 20  $\mu$ .

### Flesh Spicules.

"Flesh spicules very numerous in the parenchyma and especially the external membrane, as a rule considerably more slender and more sharply-pointed than the gemmule spicules, covered with straight spines which are often longer at the middle of the shaft than at the ends." The spines on the middle of the shaft are usually enlarged or knobbed at their ends.

They measure from about 76 to 119  $\mu$  in length and are usually very slender only from about 2 to 4  $\mu$  in thickness.

### Gemmules.

"Gemmules usually of large size with a moderately thick granular layer; spicules never very numerous, often lying horizontally on the external surface of the gemmule as well as tangentially in the granular layer; no foraminal tubule; a foraminal cup sometimes present."

The gemmules including the spicule layer about them are from about 425 to 510  $\mu$  in diameter and we find them covered with a large number of spicules very irregularly arranged.

### Gemmule Spicules.

"Gemmule spicules slender, cylindrical, blunt or abruptly pointed at the ends, feebly curved, bearing relatively long backward directed spines which are usually more numerous at the ends than near the middle of the shaft."

The number of spines on these spicules is very variable; a few have spines only near the ends with the middle portion of the spicule entirely smooth; others are thickly covered with spines throughout their whole length. The larger numbers lie between two extremes.

The spicules are from 73 to 129  $\mu$  in length and from 5 to 11  $\mu$  thick.

### Type.

The type of the species is in the British Museum.

### Distribution.

It is widely distributed in India and the var. *cerebellata* has been found near Cairo, Egypt.



## Remarks.

"All forms of *S. alba* can be distinguished from all forms of *S. lacustris* by the much closer network of the skeleton and by the consequent hardness of the sponge; also by the complete absence of green corpuscles.

Later, in the Mem. of the Ind. Mus. Vol. 5, p. 26, 1915, ANNANDALE writes as follows:

"The characters usually employed in distinguishing the species of *Spongilla* completely break down in separating *S. alba* from *S. lacustris*. Nevertheless I believe them to be distinct, for the following reasons:

"(1) Even when *S. alba* is growing side by side with green forms of *S. lacustris* as is sometimes the case, its cells never contain chlorophyll-corpuscles (cells of the alga *Chlorella*).

"(2) In the living sponge, even when it is fully expanded and in full activity, the oscula are not protected by conical dermal collars, but can be partly or completely closed by horizontal or oblique membranous diaphragms, as in *S. (Eunapius) carteri*.

"(3) The oscula are not surrounded by radiating exhalant canals of small width and running immediately below the dermal membrane; single canals similarly situated but of much greater size often open into them after running along the surface for a considerable distance.

"(4) The main exhalant canals in the interior of the sponge are of much greater calibre than in *S. lacustris*.

"(5) There is a much thicker horny membrane at the base of the sponge.

"(6) There is often a subsidiary skeleton in *S. alba*, consisting of single macroscleres fastened together to form a dense irregular network by a section of chitinoid substance.

"The fact that these characters are for the most part difficult or impossible to recognize in ordinary preserved specimens does not invalidate them from a theoretical point of view, although it renders them inconvenient to the systematist."

***Spongilla carteri* CARTER, 1859.**

## Historical Statement.

CARTER described an Indian sponge as *Spongilla friabilis* in the Journal of the Bombay Asiatic Society and in the Ann. Nat. Hist. Ser. 2, Vol. 4, p. 83, in 1849. This was in all probability our present *S. carteri*, but as there is an element of doubt, we accept his description of this species in the Annals and Magazine of Natural History, Series 3, Vol. 3, p. 334, pl. 8, figs 1-7, in 1859, as the type description. In literature this species is usually credited to BOWERBANK who examined the specimen and named it for CARTER several years before though his description of it did not appear in print until 1863 in the Proceedings of the Zoological Society of London, p. 469, pl. 38, fig. 20. Since the early description



of this widely distributed species, it, or one of its several varieties, has been recorded from many localities over the world. It seems to be quite common in Java and South China as well as in India. We have recently examined a specimen of this species from Siam.

#### Habitat.

In India this sponge grows chiefly in standing water such as ponds and lakes. ANNANDALE states that he has never seen it in running water. The China representatives, *S. carteri* var. *melli*, have all been collected from the ponds of stagnant water among the paddy fields of Kwangtung and Fukien Provinces. Many of our specimens are impregnated with mud. In Java also this sponge seems to be confined to standing water and has been found in lakes and ponds, but not in running water.

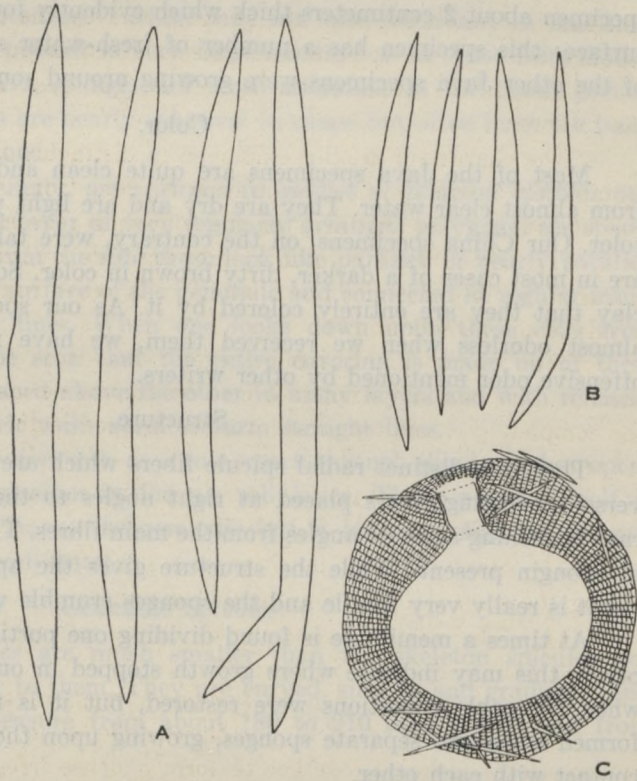


Fig. 2. *Spongilla carteri* showing:  
a. Skeleton spicules  
b. Gemmule spicules  
c. Gemmule

#### General Characteristics.

This sponge gives every evidence of being vigorous in its growth and often forms comparatively large masses. Some of our Canton dry specimens measure as much as 12 or 13 centimeters in length and have a maximum diameter of 9 centimeters. One of the Java specimens, growing around a wooden support, is 23 centimeters long and has a diameter of 6 centimeters. Most of the specimens of this sponge which we have seen are dry and grew around water plants or dead branches of trees which were submerged in the water. The Java specimens are of three general types: (1) Rather compact sponges of a dirty, light brown color with comparatively smooth surfaces and only a few conspicuous oscula. (2) Light fluffy sponges of light straw color with their entire surfaces covered with branched growths, somewhat resembling cock's combs, about one centimeter long. These growths are of an almost uniform length. This type also has



a few oscula with low craterlike elevations. These specimens have crumbled so badly in transportation that they are now in small bits. (3) There is one Java specimen about 2 centimeters thick which evidently formed a crust on some flat surface; this specimen has a number of fresh-water shells embedded in it. All of the other Java specimens were growing around some plant support.

#### Color.

Most of the Java specimens are quite clean and were evidently collected from almost clear water. They are dry and are light yellowish brown or straw-color. Our China specimens, on the contrary, were taken from dirty water and are in most cases of a darker, dirty brown in color. Some of them are so full of clay that they are entirely colored by it. As our specimens were all dry and almost odorless when we received them, we have not noticed the specially offensive odor mentioned by other writers.

#### Structure.

There are distinct radial spicule fibers which are bound together by transverse connecting fibers placed at right angles to them and also in places by rays branching at acute angles from the main fibres. There is a moderate amount of spongin present. While the structure gives the appearance of being strong yet it is really very fragile and the sponges crumble very easily under pressure.

At times a membrane is found dividing one portion of the sponge from the other; this may indicate where growth stopped in one period and began again when favorable conditions were restored, but it is more likely to have been formed when two separate sponges, growing upon the same support, came into contact with each other.

#### Skeleton Spicules.

The skeleton spicules are slightly curved, rarely straight, smooth and gradually and sharply pointed at both ends. There are at times decided variations in the size and proportions of the spicules. Some of them are very heavy, while others are thinner. Abnormal spicules with forked ends, bulbous enlargements in their centers, or other similar unusual characteristics are not uncommon. We give below a table of comparative measurements of the spicules of this sponge from several localities:

	Java	China	India
	No. 52915		
Length of spicule	259 — 366 $\mu$	240 — 325 $\mu$	255 — 350 $\mu$
Thickness of „	16 — 22 $\mu$	12 — 16 $\mu$	15 — 22 $\mu$

#### Flesh Spicules.

There are no true flesh spicules, but the small, undeveloped skeleton spicules or the free gemmule spicules may be often found in the parenchyma and are liable to be mistaken for flesh spicules, unless one is careful.



### Gemmules.

The gemmules in the China sponges are very abundant and are scattered throughout the entire structure. While they are also abundant in the Java sponges yet they are not present in such large numbers as in those from China. The gemmules in the Java sponges are more abundant in the basal portion of the colonies. Gemmules are nearly spherical in shape but often have the basal part somewhat flattened out.

They usually occur singly, are enclosed in meshes of skeleton spicules and are surrounded by a thick layer of very regularly arranged polygonal air spaces or cells. When observed from the side those look like parallel, or nearly parallel, lines perpendicular to the surface of the gemmule and connected at regular intervals by short transverse lines. When one looks down upon these cells from above, however, it can be seen that the entire covering is made up of these polygonal air cells one placed above the other in many layers and with remarkable accuracy so that their walls seem to form straight lines.

The simple pore-tube does not, as a rule, reach through this layer but opens into a funnel-shaped depression in the air cell layer. The pore-tube itself is slightly constricted as it leaves the gemmule but it becomes slightly enlarged again as it enters the air cell layer.

### Gemmule Spicules.

The gemmule spicules are much smaller than the skeleton spicules but otherwise are very similar to them. They are curved, smooth and gradually and sharply pointed. They measure from about 180 to 210  $\mu$  in length and from 5 - 8  $\mu$  in thickness.

### Type.

ANNANDALE says concerning the type: "I regard as the type of the species the specimen sent by CARTER to BOWERBANK and by him named *S. Carteri*, although, owing to some confusion, CARTER's description under this name appeared some years before BOWERBANK's. This specimen is in the British Museum, with a fragment in the Indian Museum."

### Distribution.

This sponge and its varieties are widely distributed over India, Burma and Ceylon. It is also common in southeastern China and Java and has been found in Europe, Africa, Mauritius and Madura Islands. We have recently received a specimen from Dr. H. M. SMITH in Siam.

### Remarks.

ANNANDALE created three varieties of this species in 1911 in his volume on fresh-water sponges in the Fauna of British India. He called them *mollis*, *cava* and *lobosa* giving as his reason for these varieties certain differences in form or growth from the type. He stated that the spicules in these varieties were not different from those of the type form. ARNDT in 1923, in Zool. Anzeiger, Vol. 56,



p. 79 - 80, created two additional varieties, *balatonensis* and *melli*, for reasons somewhat similar to those by ANNANDALE. ARNDT also stated that the spicules of his varieties were very similar to the type. In the Mem. of the Asiatic Soc. of Bengal, Vol. 6, p. 211, ANNANDALE places two of his varieties, *mollis* and *cava*, as synonyms of the type form.

In making our study of the Java representatives of this species we have examined the spicules of all these varieties except *balatonensis* and while we find a certain amount of variation in the dimensions of the spicules yet equal variation may be found, we believe, in some of the preparations from the same sponge. In our brief observation of fresh-water sponges we have noted very wide variations in the method of growth and in the external form of especially *Ephydatia fluviatilis* and *Trochospongilla latouchiana* and we have come to the conclusion that it is due to environmental influences rather than to inherent differences in the sponges and we do not believe that such differences are of a permanent enough character to be made the basis of classification. Since the spicules and gemmules of all of the above varieties are so constantly similar and are the permanent characters unchanged by environment, we question the propriety of the creation of these varieties.

A recent letter from Dr. W. ARNDT states that he agrees with our general view concerning these varieties except in connection with *S. carteri* var. *balatonensis*. He considers that a very constant *local form*. We have not seen this sponge.

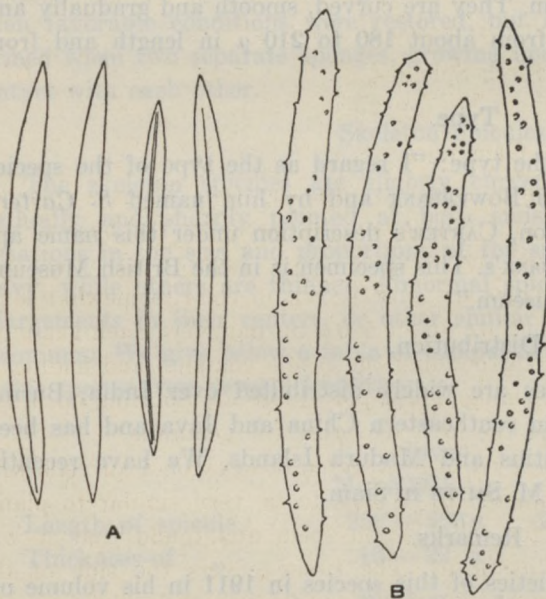


Fig. 3. *Spongilla fragilis* var. *decipiens*  
a. Skeleton spicules.  
b. Gemmule spicules very much more highly magnified than the skeleton spicules.

***Spongilla fragilis* var. *decipiens* WEBER, 1890.**

(*Spongilla decipiens* WEBER).

Historical Statement.

This sponge was secured from South Celebes and described and splendidly illustrated by WEBER in 1890 in his treatise on the fresh-water sponges of the East Indies as *S. decipiens*. ANNANDALE included it in his treatise on Indian fresh-water sponges in 1911 on the authority of WELTNER.

The following description is made up of a translation from WEBER's very full description of this form which



we have checked with the materials to which we have had access; a small bit of the cotype from the Amsterdam Museum and a similar bit from Calcutta through the Berlin Zoological Museum. The Java collections did not include any representatives of this species.

#### Habitat.

WEBER's specimen was taken from the Lapadi River near Pare Pare. It was found in strong currents and was growing on stones, the branches of trees and leaves of plants.

#### General Characteristics.

It covered its supports with thin crusts.

#### Color.

The sponge is of a grayish color.

#### Structure.

The network of fibers can be seen but they are not strong. The amount of spongin is small and the sponge is loosely built.

#### Skeleton Spicules.

The skeleton spicules are spindle-shaped, gently curved, smooth. Some of them are abruptly pointed while others are gradually and sharply pointed.

In length they vary, according to WEBER, from 220 to 250  $\mu$  with an average around 230  $\mu$ , and have a diameter of from 12 to 16  $\mu$ . My measurements show them to be somewhat larger, length from 255 to 298  $\mu$ .

#### Flesh Spicules.

There are no flesh spicules.

#### Gemmules.

We give in full the substance of a free translation from WEBER's splendid detailed description of the gemmule. The gemmules occur in the base of the sponge. They are very numerous and form a single layer where they are crowded into a cohering plane. They are dark brown in color, somewhat lens-shaped due to vertical pressure and are about 500  $\mu$  in diameter. Each gemmule consists of a brown horny cover surrounding the inside contents and ending in a short pore-tube with a simple opening. These pore-tubes are pointing up in the sponge but do not project beyond the layer covering the gemmule.

The gemmule is covered by a layer of pentagonal or hexagonal air cells with thick cell walls. They were considered by WEBER to be very similar to plants cells and he tried the reaction for cellulose on them and found that it was animal tissue, hence the name *decipiens*. The tissue covers the side of the gemmule with one layer, around the central it is thicker and stratified and this area projects toward the other gemmules uniting them into one plane. The tissue forms a kind of ring around this area and it consists of angular cells with thick walls arranged in more or less regular columns. The gemmule has



two regular layers of spicules covering it, one lies next to the chitinous cover, then comes a layer of air bubble cells and then another regular layer of spicules in the bubble cells. The layer of cells is covered again by an irregular layer of gemmule spicules. These air cells are very thin or almost absent from the basal portion of the gemmules.

#### Gemmule Spicules.

The gemmule spicules are comparatively stout, tapering somewhat toward their ends, blunt or abruptly pointed, straight or slightly curved. The central portion is usually larger and may often be somewhat swollen. The entire surface is covered by spines of varying size. The spicules vary in length from 80 to 140  $\mu$  with an average length of about 110  $\mu$ .

#### Type.

The type of this variety is in the Amsterdam Museum. Through the kindness of that Museum we have a small gemmuleless *cotype* in our collection.

#### Distribution.

The original locality at which this sponge was collected was in the Lapadi River at Sare-minja near Pare-Pare on the western coast of Southern Celebes. ANNANDALE reports it in Fauna of British India, p. 97, 1911, from the museum „tank” in Calcutta on the authority of WELTNER, but he seems to question the determination and considers that the sponge examined by WELTNER must have been *S. fragilis* var. *calcuttana* which he found to be common in the „tank”.

#### Remarks.

ANNANDALE (l.c.) states that „this (?) local race (WEBER's *S. decipiens*) is distinguished by the fact that the foraminal tubules are invariably short and straight and thickened at the tips, and that the gemmule spicules do not occur on the external surface of the cellular coat of the gemmules ..... Perhaps the Japanese form which has spindle-shaped gemmule spicules with comparatively short and regular spines, should be considered as a third subspecies, and the Siberian form as a fourth.” WEBER calls attention to the following differences between the type form of *S. fragilis* and his sponge: (1) *S. decipiens* has two layers of spicules separated by air bubble cells; *S. fragilis* does not show this characteristic. (2) Neither does *S. fragilis* have the ring of cells projecting around its central area which is very characteristic. (3) The chimney-like prolongation of the pore-tube so common in *S. fragilis* is lacking in his *S. decipiens*. (4) The grouping of the gemmules is also different: *S. fragilis* has them bound together in small irregular groups, while *S. decipiens* showed as many as 60 gemmules together in one plane. (5) The spicule form also differs.

ANNANDALE (in Rec. Ind. Mus. Vol. 1, pp. 390-391, 1907) gives us the following key to the forms related to this species.



Subgenus **Spongilla** (Gemmules bound together in groups each of which is enclosed in a mass of "polygonal" cells)

A. *Gemmule spicules apparently not arranged in two layers.*

- a. Skeleton spicules amphioxious: fibers of skeleton delicate. . . . . *S. decipiens* WEBER

B. *Gemmule spicules clearly arranged in an outer and an inner layer.*

- b. Framework of skeleton not very stout; skeleton spicules amphioxious; sponge incrusting. . . . . *S. fragilis* LUDY

- b.1. Fibers of skeleton moderate, forming a close hard reticulation; sponge forming spherical or spindle-shaped masses. *S. crassissima* ANNANDALE

- b.2. Fibers of skeleton extremely massive, especially towards the external surface, skeleton spicules sausage-shaped, sponge incrusting. . . . . *S. crassior* ANNANDALE

**Spongilla proliferens** ANNANDALE, 1907.

Historical Statement.

Under the name of *Spongilla cinerea* WEBER in 1890 described, in his Spongillidae des Indischen Archipels, a sponge which had been taken in three different localities in the East Indies. He named these specimens *S. cinerea* CARTER, but later ANNANDALE compared representatives of these East Indies forms with the type of CARTER's sponge and in his treatise on Indian Fresh-Water Sponges in The Fauna of British India, p. 74, 1911, stated that he had no doubt that WEBER's *S. cinerea* was the same as his *S. proliferens* described in the Journal of the Asiatic Society of Bengal, p. 15, fig. 1, 1907. Later this form, *S. proliferens*, was made a variety of that cosmopolitan species, *S. lacustris* by ANNANDALE. Mr. SCHRÖDER, who has kindly read these notes for me, states that he considers *S. proliferens* as a distinct species and easily separable from *S. lacustris* by the fact that in the former the spines on both the flesh spicules and the gemmule spicules frequently become forked or spined, while those of the latter do not show this characteristic. We accept this

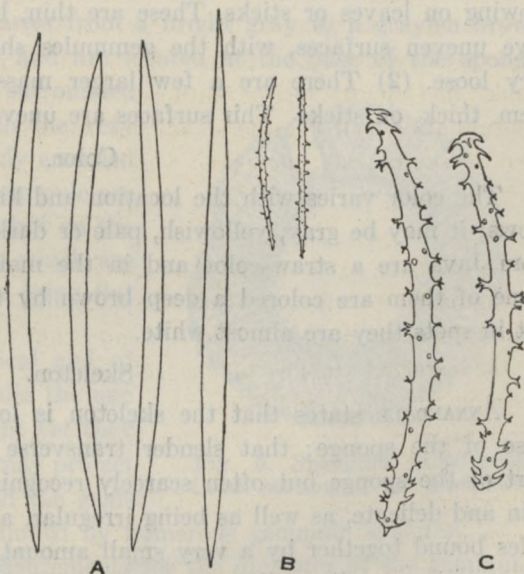


Fig. 4. *Spongilla proliferens*  
a. Skeleton spicules.  
b. Flesh spicules.  
c. Gemmule spicules enlarged to show kinds of spines.



viewpoint as we find it to be in accord with the observations we have made on the specimens in our collection.

In our description we have utilized the information furnished by ANNANDALE and WEBER concerning the forms examined by them, but have modified this to accord with our own findings in the specimens of *S. proliferens* from Java kindly sent us by the Buitenzorg Museum.

#### Habitat.

This sponge, found in both still and in rapidly running water, frequently forms soft shallow cushions, not often more than 10 cm. in diameter. It was found fixed tightly on the roots, stems or leaves of water plants. It seems confined to ponds which are permanent; temporary ponds, it is claimed, do not produce it.

#### General Characteristics.

These sponge cushions are frequently irregularly circular in outline. VORSTMAN states that she finds this species often with digitiform branches of some centimeters in length. The oscula open upon a more or less smooth surface and are „surrounded by deep cone-shaped collars”. The sponges have a characteristic cucumber-like odor.

The specimens sent us are of two types: (1) small, irregular patches growing on leaves or sticks. These are thin, being only a few mm. thick, and have uneven surfaces, with the gemmules showing through. The structure is very loose. (2) There are a few larger masses, 6 to 10 cm. long and 2 to 3 cm. thick, on sticks. Their surfaces are uneven and the oscula are large.

#### Color.

The color varies with the location and kind of water in which the sponge grows; it may be gray, yellowish, pale or darker green in color. The specimens from Java are a straw-color and in the main are free from much sediment. Some of them are colored a deep brown by the presence of foreign materials but in spots they are almost white.

#### Skeleton.

ANNANDALE states that the skeleton is loose and feebly reticulate at the base of the sponge; that slender transverse fibers are visible in the upper part of the sponge but often scarcely recognizable at its base. The fibers are thin and delicate, as well as being irregular, and are made up of very few spicules bound together by a very small amount of spongin. This description fits our specimens quite well.

#### Skeleton Spicules.

The skeleton spicules are smooth, gently curved or straight, spindle-shaped and gradually and sharply pointed.

They are from 200 to 280  $\mu$  long with an average of about 240  $\mu$  and are about 11  $\mu$  in diameter.


WEBER noted a marked variation in length of the skeleton spicules of the sponges collected in the different places.



	Rivulet near Bari	Makassar	Pare Pare
Length of spicules	260 — 328 $\mu$	240 — 250 $\mu$	200 — 280 $\mu$
Average length	300 $\mu$		

VORSTMAN finds them to average about 330  $\mu$  in length in specimens examined by her. We find a variation about as indicated above in our preparations from several specimens all of which we take to be this species or varieties of it.

#### Flesh Spicules.

The flesh spicules are curved, rarely straight, very thin, gradually sharply pointed and thickly covered all over by minute spines. Some of the spines on these spicules may be divided at their ends into a Y-shape, others may end in three smaller spines, thus . WEBER notes the following variations in the size of these spicules.

	Bari	Makassar	Pare Pare
Length	60 — 76 $\mu$	44 — 60 $\mu$	
Average	68 $\mu$		72 $\mu$

In our No. 53830 they measure from 70 to 76  $\mu$  in length.

#### Gemmules.

The color of the gemmules varies from a bright gray to a grayish brown color. They are usually numerous and are located at the base of the sponge. They are variable in size and are surrounded by a thick granular coat in which the very large numbers of spicules are thickly crowded together. The spicules next to the gemmule are usually nearly vertical in position, but on the outer area there are many spicules which are arranged irregularly many of them lying flat upon the surface.

The pore-tube is short, cylindrical and of more or less uniform diameter, while the one illustrated herewith is about straight yet they are often contorted. The pore-tube may project beyond the protective layer around the gemmule and when it does it is surrounded by numerous gemmule spicules.

WEBER notes the following measurements for the diameter of the gemmules in each of the three places:

	Bari	Makassar	Pare Pare
Diameter	400 $\mu$	400 $\mu$	400 $\mu$

VORSTMAN calls attention to the fact that gemmules of her specimens measure about 600  $\mu$  in diameter; our measurements are 510  $\mu$  to 595  $\mu$ . CARTER's original measurements make the diameter of the gemmule 370  $\mu$ . WELTNER's specimen from which our drawing was made measures about 580  $\mu$  in diameter.

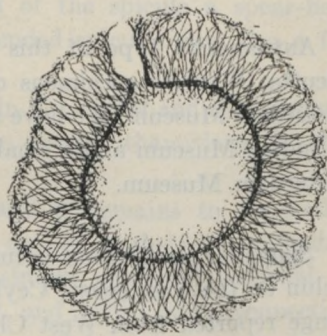


Fig. 5. *Spongilla proliferens*  
Cross section of the gemmule.



## Gemmule Spicules.

The gemmule spicules in our No. 53830 are cylindrical, often decidedly curved, rarely straight and bear more or less blunt ends. In some other specimens these spicules are less curved than in our No. 53830.

The spines, which may number 25 to 45 or more, are longer and heavier than the similar ones on the flesh spicules; are more or less evenly distributed over the entire surface of the spicule; are sharp and frequently curved inward near the ends of the spicules and are sometimes so arranged on the ends as to form a rudimentary disk. The spines are frequently forked or provided with secondary spines growing from the primary ones as is also the case in the smaller flesh spicule spines. Our *cotype* of this species from the Indian Museum also shows this character.

As a rule it is possible to distinguish these from the flesh spicules by the fact that they are larger, thicker, more blunt at the ends and bear heavier spines.

	Bari	Pare Pare	Makassar
Length of gemmule spicule	56 — 92 $\mu$	56 — 120 $\mu$	52 — 72 $\mu$
Average of gemmule spicule	76 $\mu$	72 $\mu$	66 $\mu$

VORSTMAN found that they measured 90  $\mu$  in length. In our No. 53830 they vary from 82 — 100  $\mu$  in length. In some other specimens they average around 70 — 80  $\mu$  in length.

## Type.

ANNANDALE's type of this species is preserved in the Indian Museum in Calcutta. WEBER's specimens of this *S. cinerea* are probably preserved in the Amsterdam Museum. We have a small *cotype* of the first without gemmules from the Indian Museum and a small bit of WEBER's sponge from Makassar from the Amsterdam Museum.

## Distribution.

*Spongilla proliferens* occurs "all over eastern India and Burma; also in Cochin on the west coast; Ceylon; West China, Java, Flores and Celebes". The sponge reported from West China as *S. proliferens* has proved to be the type from of *S. lacustris*.

WEBER reported this sponge (as *S. cinerea*) from (1) a rivulet Batjo Keke near Pare-Pare on the West Coast of South Celebes, (2) a rivulet near Bari on the northern coast of West Flores, (3) at Makassar in a sawah pond.

VORSTMAN reports it from the following localities in West Java: (1) ponds in Botanical Garden, (2) Lake near the terminus of Tjitajam, (3) Siteo G. Poetri, (4) Siteo Babakan, (5) Siteo Tjibinoeng. It was also found in the following places in East Java: (1) Rawah Bening (South Kediri), (2) Lake of Ngebel (Madioen) 830 meters elevation.

In a list sent me by the Buitenzorg Museum of certain collections made elsewhere, this sponge is mentioned as having also been found in the "Isle of Lombok (Narmada)".



## Remarks.

ANNANDALE states that "*S. proliferens* can be distinguished from all forms of *S. lacustris* and *S. alba* by the fact its gemmules possess a foraminal tubule; from *S. cinerea* it can be distinguished by its color and its smooth skeleton spicules, and from *S. travancorica* by its free gemmules".

In addition to the form described above which differs somewhat from ANNANDALE's type we find in our material two other forms which may with further study prove to be distinct varieties of the sponge under consideration. We give below brief notes on representatives of these two forms.

(1) This sponge (No. 53765) has skeleton spicules varying from 230 — 272  $\mu$  in length and 10 — 16  $\mu$  in thickness. The spicules are of very nearly the same diameter throughout their entire length and terminate in rounded, often finely spined, ends. The spicules are smooth or sparsely covered by very minute spines.

The gemmule spicules of this form resemble those of No. 53830 rather closely.

(2) Sponge No. 53766 represents another form and has spicules of about the same length as No. 53765 but they will average considerably thinner than that one; their thickness being from about 8 — 10  $\mu$ . They are smooth or bear very few minute spines. They taper gradually toward their ends and become abruptly sharpened, the sharpened ends frequently being covered with very fine simple spines. In some of the spicules there is a slight enlargement just before the point is formed at the end, thus giving the end of the spicule a spear-head shape. Mixed with these are found a few round ended spicules and also a few sharp pointed ones.

The flesh spicules are shorter and thicker than in No. 53830 and the gemmule spicules (about 76  $\mu$ ) are also shorter and more slender than those of that specimen.

This is evidently a very variable sponge and it remains to be settled whether these three different sponges are constant enough in their dissimilarities to be designated as varieties or whether they simply represent seasonal or environmental variations which are not constant and which have connecting characteristics. Further study of the living sponges will be necessary to decide this question. We hope that someone living near the places will study this problem.

**Spongilla sumatrana** WEBER, 1890.

## Historical Statement.

This sponge was found in the fresh-water lake of Singkarak, Sumatra and was fully described and illustrated by WEBER in 1890 in his *Spongillidae des Indischen Archipels* p. 38. Since that time varieties of it have also been found in India: *S. sumatrana* var. *indica* ANNANDALE, and *S. sumatrana* var. *gravelyi* ANNANDALE. Both of these were described — the former in 1908 in *Rec. Ind. Mus.* Vol. 2, p. 25 and the latter in 1912 in *Rec. Ind. Mus.* Vol. 7, p. 385.



*S. sumatrana* var. A. WELTNER has been found in the Nile System in Africa and var B. WELTNER, has been found in the coastal region of Tropical East Africa. These two forms have been described by WELTNER in Wiss. Ergebn. d. Deutsch. Zentral-Afrika-Expedition 1907, Bd. 4, Zool. 2, pp. 475 - 476.

The following description is based upon WEBER's original paper and our observations upon a small specimen without gemmules kindly given us by the Amsterdam Museum and some slide preparations loaned us by Dr. ARNDT of the Berlin Museum.

#### Habitat.

The sponge was found growing in thin layers of circular or irregular shapes firmly attached and covering the stones. These thin crusts were on stones covered with water about half a meter deep, and were covering areas about the size of one's hand. It was with difficulty that these crusts could be removed.

#### General Characteristics.

The surface of the sponge is smooth.

#### Color.

The crusts were light gray in color. Our specimen in alcohol is a clear transparent bit with small particles of sediment in it.

#### Structure.

The skeleton is made up of large, rather loosely organized and thin meshes formed by only a few spicules.

#### Skeleton Spicules.

The skeleton spicules are straight spindle-shaped with gradually and sharply pointed ends. The spicules are thinly covered, except near their ends, by very short spines which have rather large bases. In rare cases, long blunt spines equal in length to half the diameter of the spicules may be found on some of these spicules. They average around 260  $\mu$ , but vary from 210 to 270  $\mu$  or more in length.

#### Flesh Spicules.

While the flesh spicules are abundant throughout the sponge, yet they seem to be more numerous in the region of the gemmules. There are two kinds



Fig. 6. *Spongilla sumatrana*  
a. Skeleton spicules.  
b. Gemmule spicules.  
c. Two types of flesh  
spicules (after WE-  
BER).



of these spicules both are curved, but one is smaller, shorter, spindle-shaped with sharp pointed ends and is entirely covered with very minute spines.

The other kind is larger, cylindrical, curved, has blunt ends and is also covered by spines which are larger and less numerous. They are more abundant around the ends where they are somewhat curved toward the center of the spicule. The average length of this spicule is 67  $\mu$  but the extremes may measure from 60  $\mu$  to 92  $\mu$ .

#### Gemmules.

There are only a few gemmules which are lying singly upon the basal portion of the sponge. They are grayish brown in color and are somewhat flattened upon the upper side. The gemmule is covered by a horny capsule which continues into a short pore-tube which ends in a simple opening at the level of the covering layer of the gemmule. It is *not* sunken in like a funnel. The gemmules measure from 450 — 600  $\mu$  in diameter.

#### Gemmule Spicules.

The gemmule spicules are closely crowded together in the poorly developed gemmule cover and are placed in a tangential position to the surface of the gemmule. They are sausage shaped, short, thick, usually gently curved, rarely straight, are of a uniform diameter and have rounded ends. They are covered over their entire surfaces by very minute spines.

Their average about 35  $\mu$  in length but may vary from about 32 to 40  $\mu$ . Their diameter varies even less and is usually about 13  $\mu$ .

#### Type.

The type of this sponge is preserved in the Amsterdam Museum and through the kindness of the authorities of that Museum we have a small gemmuleless *cotype* in our collection.

#### Distribution.

The type form of *S. sumatrana* has been reported according to ANNANDALE, from Sumatra, West India and East Africa and the two varieties named above have been found in India. Two other varieties have been reported by WELTNER from Africa.

#### Remarks.

WEBER summarizes the characteristics of this sponge as follows:

1. It forms crusts.
2. The gemmules are spherical, the pore-tubes simple.
3. The gemmule spicules are curved, very short and thick, cylindrical sausage-shaped with rounded ends, entirely covered with thin spines. They are crowded tangentially around the gemmule.
4. The skeleton spicules are spindle-shaped, sharply pointed, straight, covered over their central portion with spines.
5. Flesh spicules long, straight or curved, spined.



*S. sumatrana* var. *indica* ANNANDALE, is closely related to *S. sumatrana* but differs from it by the fact that it has "blunt, almost truncated megascleres and comparatively slender gemmule-spicules," also it has its gemmules free. *S. sumatrana* var. *gravelyi* can be distinguished from *S. sumatrana* "by its peculiar gemmule spicules, much more strongly spined flesh spicules and smooth megascleres".

### ***Ephydatia bogorensis* WEBER, 1890.**

#### Historical Statement.

This very interesting sponge was first found by MAX WEBER in the ponds of the Botanical Garden in Buitenzorg, Java, and also in a pond near Makassar on Celebes. He described it in 1890 in *Zoologische Ergebnisse einer Reise in Niederländisch Ost-Indien*, Vol. I, p. 33-35. The writer next collected this species in October 1917 from the canal near the jetty of the Soochow University in Soochow, China, and sent it along with other sponges to ANNANDALE. It was described by him in 1918 in the *Memoirs of the Asiatic Society of Bengal*, Vol. VI, Part IV, p. 205. The writer and C. F. Wu, in working over the fresh-water sponges of China, redescribed and illustrated the China representative of this species in the *China Journal of Science and Arts*, Vol. VII, No. 7, p. 393-394. Some time ago we stated that we had not been able to rediscover this species in our Soochow collections, but in carefully working through a lot of small specimens recently (May 4, 1929), we found a part of the original Soochow specimen in a small vial in alcohol. Dr. A. G. VORSTMAN, in 1927, again collected this sponge in the ponds of the Botanical Garden in Buitenzorg, Java, and recorded her find in *De Tropische Natuur*, No. 11, p. 184.

#### Habitat.

In every case so far reported, *Ephydatia bogorensis* has been found in standing water or where there is very slight motion to the water. WEBER found it growing on leaves which had fallen into the ponds and also on the underside of leaves growing in the water. VORSTMAN's specimens, which were sent to us for examination, were also on the leaves of plants which had

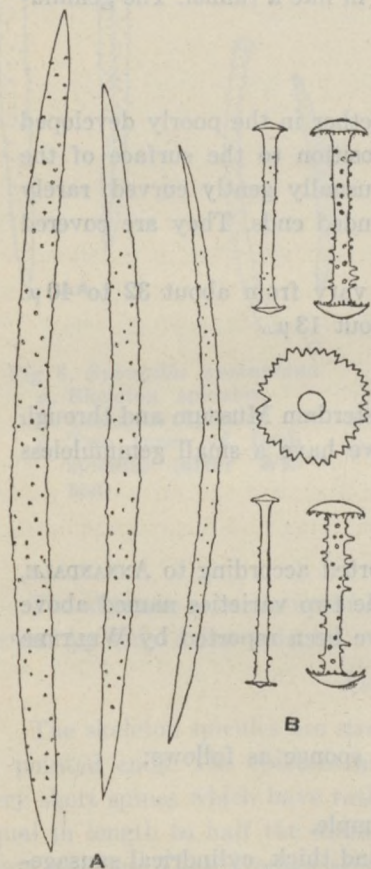


Fig. 7. Skeleton (A) and gemmule (B) spicules of *Ephydatia bogorensis*. The smaller gemmule spicules are young ones not fully developed.



been covered with water. Our China specimen was found growing upon a small water weed in very shallow water.

#### General Characteristics.

The Java specimens of this species which we have seen, from thin circular or irregular crusts of very small size. The specimens under observation, — one of them kindly given us by the Amsterdam Museum as a *cotype* of WEBER's original sponge, — are more or less circular and measure from four to nine mm. in diameter; they are thickest in the center and become thinner toward the outer edges of the colony. One Java specimen is a small mass which measures about eight by fifteen mm. The Soochow specimens are somewhat loose in texture and form small irregular masses having no definite shape. In its small size it is quite unlike the more vigorous *E. fluviatilis* which forms larger colonies.

#### Color.

The Java specimens are a light brown or straw color. The Soochow sponge is almost transparent in alcohol. The light brown color of the gemmules makes them easily distinguishable in the clear sponge mass.

#### Structure.

The skeleton is a network of rather large open meshes which are formed of bundles of few spicules bound together by a small amount of spongin. Small tufts of spicules project in places above the smooth surface of the sponge.

"Slender horizontal spicule fibers are well defined, branching freely in the sponge, but the transverse fibers are irregular and ill defined".

#### Skeleton Spicules.

The skeleton spicules of *Ephydatia bogorensis* collected by VORSTMAN in Java in 1927 and of that collected by the writer in Soochow in 1917, are very similar. They are both long, slender, gradually tapering and abruptly pointed, with only very extremely rarely one with even a bit blunted or rounded ends. In the Java sponge the spicules are probably slightly more curved and the straight spicules are rarer than in the Soochow specimen. Both sponges have their spicules, in most cases, covered by very minute spines, but the portions of the spicules near the pointed ends are generally free from spines. The Java sponge frequently has an enlarged bulb-like area in the middle of the skeleton spicules.

We find the skeleton spicules of the *cotype* to be straight or slightly curved, as a rule somewhat shorter than those of the other two sponges and with blunter or more rounded ends, though there are scattered through our preparations of the *cotype* a few sharp pointed spicules. WEBER illustrates both types of spicules in his drawings which accompany the original description of the species. In these, the very fine spines give the spicule a roughened appearance and the minute spines extend to the very end, even cover the tip of the rounded end of the spicule. Our findings, in comparing these three specimens,



raise the question as to whether the cotype of WEBER was not mixed with some other sponge. Our specimen had no gemmules in it.

We have carefully measured these spicules and get the following results:

	WEBER's specimen cotype	VORSTMAN's Buitenzorg Specimen	GEE's Soochow Specimen
Length of spicules	230 — 282 $\mu$	289 — 357 $\mu$	247 — 332 $\mu$
Thickness of spicules	14 — 15 $\mu$	14 — 16 $\mu$	14 — 16 $\mu$

#### Flesh Spicules.

WEBER mentions certain heavier spicules, sometimes ending bluntly, which he thought performed the function of flesh spicules. We find it difficult to distinguish these as a group from the skeleton spicules and are rather inclined to consider them as simply heavier skeleton spicules. We cannot distinguish a separate group of such spicules in either VORSTMAN's Java collections or in our Soochow specimen. We also have immature gemmule spicules in our preparations, but these are quite distinct and are not to be confused with flesh spicules.

#### Gemmules.

Gemmules seem to be very rare in the Java specimens of this sponge; when present, quite frequently only a solitary one is found. The Soochow specimen which we recently located in our collection is very full of gemmules and they are a light brown in color. WEBER says the gemmules of the Java sponge are gray. They are spherical in shape and are covered by a single layer of closely crowded gemmule spicules arranged with the inner rotule resting upon the surface of the gemmule and the shaft perpendicular to that surface, while the outer rotules are held together by a thin membrane. There is a single short pore tube.

We have measured five gemmules from the Soochow sponge, with the covering layer of spicules, and they were all within a few microns of each other, about 530  $\mu$  in diameter. WEBER's specimens measured about 400 microns and VORSTMAN's around 600 microns.

#### Gemmule Spicules.

We have found in all of the materials which bear gemmules, a number of stages in the development of the gemmule spicules. In the early stages they are simple cylindrical spicules with slightly enlarged ends; the shaft is usually smooth at this stage. Later stages show a thicker shaft, minute spines make their appearance upon it and the enlargements or rotules at the two ends become larger and serrations are visible. Finally, when mature, the shaft becomes heavily spined and the rotules at both ends become somewhat bowed, resembling the shape of an umbrella, with the edges pointed inward toward the shaft. The serrations of the two equal disks or rotules are usually very numerous, fine and shallow. At times, however, larger lobes with smaller serrations occur. The spines on the



shaft are often heavy and numerous and are larger and more numerous near the ends than in the center of the shaft. They may, at times, almost equal in length the diameter of the rotule. The number of spines is variable, WEBER says, from 20 to 30; my count gives 22 to 32.

WEBER gives the length of the gemmule spicule as 54 - 60  $\mu$ ; we make VORSTMAN's from 68 - 76  $\mu$  and those from our Soochow sponge from 66 - 76  $\mu$ . WEBER gives the diameter of the disks as 18  $\mu$ ; we make VORSTMAN's from 23 - 27  $\mu$  and those of our Soochow sponge 20 - 26  $\mu$  in diameter.

#### Type.

The type of this species is in the Museum in Amsterdam, Holland. We have a small *cotype* without gemmules in our collection.

#### Distribution.

This sponge is collected, up to the present, from the following localities:

1. Botanical Garden, Buitenzorg, Java, by both WEBER, 1890, and VORSTMAN in January and March, 1927.
2. Near Makassar, Celebes, by WEBER, 1890.
3. Siteo Babakan, West Java, by VORSTMAN on May 6, 1927.
4. Soochow, China by the writer on October 25, 1917.

#### Remarks.

It may be wise to make the Soochow sponge and the one found by VORSTMAN in Java, a variety of WEBER's type, but it would be necessary first to secure more material in order to judge the constancy of the rounded ends of the skeleton spicules in WEBER's sponge. We have only one small bit of this type material and only the one specimen of the Soochow sponge.

### ***Ephydatia crateriformis* (POTTS) 1882.**

#### Historical Statement.

*Ephydatia crateriformis* was first described as *Meyenia crateriformis* by POTTS in 1882 in the Proceedings of the Academy of Natural Sciences of Philadelphia, pp. 12-13. Again in his Monograph in 1897 in the Proc. Acad. Nat. Sci., the same author gave another description of this sponge. HANITSCH reported this form from Ireland in 1895 but this was later shown by STEPHENS in the Proceedings of the Royal Irish Academy in 1912 to be an error in identification and it is not yet known from Europe. ANNANDALE in 1907 described a sponge, *E. indica*, as a new species in the Journal of the Asiatic Society of Bengal, p. 20; this he later decided was the same as *E. crateriformis*. VORSTMAN reported this sponge from several places in Java in De Tropische Natuur, No. 11, in 1927. We have also found the same sponge in its typical form in China and have



recently (May, 1929) described an interesting variety of it from Canton, China, in the Bulletin of the Peking Society of Natural History, Vol. 3, pt. 3, pp. 1-4, as *E. crateriformis* var. *cantonensis*.

#### Habitat.

POTTS found his specimens on "fixed or floating timber in shallow water" in Pennsylvania; ANNANDALE found it growing on water plants in India. VORSTMAN has reported it from five different localities in ponds or lakes in Java and the several specimens sent us are all on either plant stems or leaves or on sticks which were evidently free-floating in the waters. The typical China specimens were all also taken from plants growing in still waters, though the new variety referred to above was found covering small clods of red clay in a paddy field.

#### General Characteristics.

The sponge usually forms soft irregular patches on its support, though sometimes it spreads out between two supports forming a thin film. Most of the specimens from Ja-

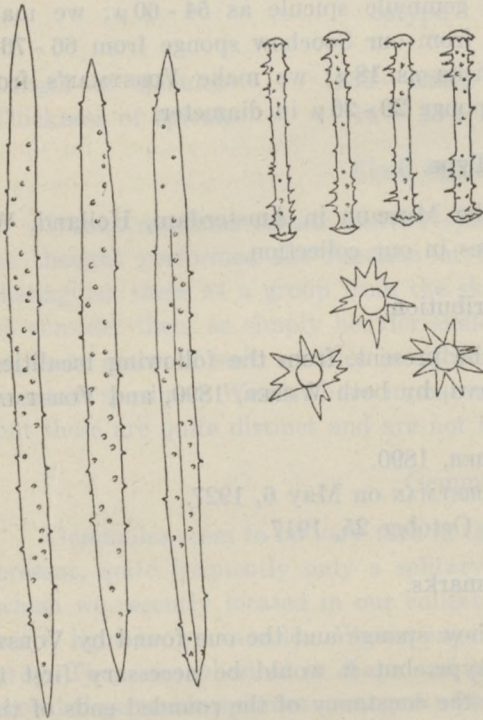
Fig. 8. Skeleton and gemmule spicules of *Ephydatia crateriformis*.

va are more or less spindle-shaped masses around bits of stick, they are thicker in the center and taper off toward each end of the colony. They range from 8 or 10 centimeters in length to as much as 15 or 18 cm. In the thickest part some of them in dry condition are 15 to 20 mm. in thickness from the support to the surface. In some dry specimens the surface is nearly smooth and large irregularly shaped oscula open here and there upon it. In other specimens the surface is covered with numerous small tufts and the oscula lie between these tufts.

One small Java specimen about 10 mm. thick seems to have been removed from a flat surface. Our China specimens are small irregular masses, much smaller than the Java specimens, entangled among the leaves of small water plants.

#### Color.

The color of this sponge, as is commonly the case with all sponges, is much influenced in color by the organic content of the water or the sediment which





it contains. In clear, clean water the sponge may become almost transparent, but our specimens vary from one of this nature in alcohol to dried ones which are black; some of them are clean, yellowish brown, others are grey, while one or two are quite black.

#### Structure.

PORTS states that the texture of the sponge is very loose and that it forms no tangible skeleton. ANNANDALE says: "skeleton very delicate; radiating fibers rarely consisting of more than two parallel spicules; transverse fibers far apart, frequently consisting of single spicules; very little spongin present." VORSTMAN also calls attention to the fact that the sponges tear apart very easily and are not very compact.

We find it difficult to trace any regular skeleton fibers throughout the sponges but the whole structure seems to be made up of large, loosely formed, fragile meshes penetrated all through by numerous canals. When dry, the specimens crumble very easily.

#### Skeleton Spicules.

The skeleton spicules (No. 53741) are spindle-shaped, slightly curved or straight, gradually and sharply pointed. They are covered throughout their entire length with heavy, short spines which continue in decreasing size on to near the tip of the spicule.

These spicules closely resemble those of the Canton variety but are somewhat longer and bear comparatively slightly smaller spines than the China sponge.

The Java sponge has its spicules of approximately the same length as those of the American sponge from the type locality but they bear more and heavier spines.

	American	Chinese	Javanese
Length of spicules	238 — 272 $\mu$	195 — 213 $\mu$	250 — 260 $\mu$
Thickness of spicules	8 — 10 $\mu$	8 — 11 $\mu$	10 — 11 $\mu$

#### Flesh Spicules.

This sponge has no flesh spicules.

#### Gemmules.

The gemmules are usually very abundant, free, spherical and scattered throughout the entire sponge. We have found them in some of the Java specimens only in the basal portion of the sponge. Each gemmule is covered by a thick protective coat in which the long spicules are generally placed perpendicularly to the surface of the chitinous membrane in a layer one spicule thick. The simple pore-tube is not as long as the gemmule spicules and it ends as a rule in a crater-like depression in the granular layer. This peculiarity has given the species its name.



POTTS gave the diameter of the gemmules of the American sponge as 325  $\mu$ , VORSTMAN found the Java sponge to be about 370  $\mu$ , and we found the China sponge to average 375  $\mu$ , some few reaching as much as 400  $\mu$ .

### Gemmule Spicules.

The gemmule spicules are long, usually straight or only slightly curved, covered with heavy spines which are somewhat crowded toward the ends of the spicules. At times some of the spines forming the rudimentary rotules are re-curved, though as a rule the spines on the shaft are straight. Spines numbering from 3 to 6 or often more are arranged around the enlarged and expanded end of the shaft forming a rudimentary rotule. There is considerable variation in these spicules and there may probably be some slight reason for placing it in the genus *Spongilla* as ANNANDALE has done if we agree to include all of the forms which have in the past been included under this species. We must confess that we are doubtful about some of the sponges which have been put in this species. We feel justified however in restoring it to the genus *Ephydatia* since we find that in the large majority of cases the rotule is clearly formed by the expanded end of the shaft with its radiating spines and rarely do these ever end in a spine as is the case in some of the other sponges which have skeleton spicules with rounded ends.

Here again the Java sponge is closer to the American sponge than to the China one in the arrangement of the spines on the shaft. In both the Java and the American sponge the center of the shaft is nearly free of spines or bears fewer spines than in the Canton sponge. As a whole, however, the Java sponge bears a larger number of spines than the American one.

	American	Chinese	Javanese
Length of spicule	59 — 68 $\mu$	68 — 72 $\mu$	68 — 76 $\mu$
Diam. of rotule	about 10 $\mu$ in all forms.		

### Type.

The type of this species is in the United States National Museum. We have a bit of material from the type locality, Brandywine Creek, Pennsylvania, kindly given us by the Philadelphia Academy of Natural Sciences. We also have a small specimen of this species from the United States National Museum, though it is not marked as a *cotype*.

### Distribution.

This sponge or one of its varieties is widely distributed in the United States, in India and Burma, and has been found in the east central and southern part of China. VORSTMAN reports that the form with sharp pointed skeleton spicules has not been found in the eastern part of Java but that it has been found in the following localities in West Java:



- (1) Pond in the Botanical Garden, Buitenzorg
- (2) Lake near the stopping place of Tjitajam
- (3) Lake of Tjigombong
- (4) Small lakes on English Plain (Kamodjan)

#### Another Related Sponge.

Another related sponge which has skeleton spicules with rounded ends has also been found in the following places:

- (1) Lake near the stopping place of Tjitajam
- (2) Lake of Pendjaloe.

This sponge differs in several respects from the sponge described above.

The skeleton spicules are of approximately the same length as the *E. crateriformis* but they average somewhat thicker in diameter and they bear smaller spines; they taper gradually and slightly to their ends which are usually rounded and covered all over with minute spines, the terminal one sometimes being larger than the others. Among the spicules are found now and then one which has the spindle shape and sharp points; others may be found which resemble the usual ones but become abruptly sharp pointed with numerous minute spines covering the pointed tip.

The gemmule spicules are also different from the Java *E. crateriformis* and resemble somewhat those originally described by ANNANDALE as *E. indica*. In length it is nearly the same as the Java *E. crateriformis*; the distribution of the spines on the shaft is also similar, but the spines near the center of the shaft are more numerous in this form. The gemmule spicule often ends in a single spine at the base of which is a circle of spines forming a rudimentary rotule. In many cases this spine may be absent, in some cases one end of the spicule bears the spine while the other has the rudimentary rotule without any sign of a spine. The spines on the shaft are somewhat fewer and smaller than on the Java form of *E. crateriformis*.

#### Remarks.

This is a very variable sponge. ANNANDALE noted the same variation in the skeleton spicules to which VORSTMAN has called attention and stated that the two types were sometimes found in the same locality. Both the rounded skeleton spicule and the sharp-pointed forms were also found by VORSTMAN in one locality in Java. The China forms so far examined all have the skeleton spicules with sharp-pointed ends but they vary in size and there is also a good deal of variation in the gemmule spicules.

ANNANDALE, 1911, states that "the systematic position of *S. crateriformis* is almost exactly intermediate between *Euspongilla* and *Ephydatia*, to which genus it has hitherto been assigned. I think, however, that taking into consideration its close relationship to *S. hemiphydatia*, it is best to assign it to *Spongilla*, as its rudimentary rotules never form distinct disks". *S. permixta* also is somewhat similar to this species.



We hope to come back to this study at a later date when we have a larger quantity of material from additional localities for comparison. It hardly seems likely that these two Java sponges are one and the same species.

It is our opinion that the form of sponge illustrated herewith should be called an *Ephydatia*. While the rotules are formed by the union of the bases of the spines around the ends of the spicule, yet they form distinct rotules in most cases larger than the diameter of the shaft. These rudimentary rotules conform more closely to the definition of the genus *Ephydatia* than they do to the genus *Spongilla*.

### ? *Ephydatia fluviatilis* auct.

#### Historical Statement.

This is a very widely distributed species and it is very variable in structure and habit of growth. WENER gives a good brief description of his specimens of this species in his *Spongilidae des Indischen Archipels* in 1890, and we give a free translation of his description below. ANNANDALE holds that this Java sponge is *Ephydatia meyeri* and we also give his reasons below. We also add our comments based upon the examination of a small bit of WEBER's specimen kindly provided by the Amsterdam Museum.

#### Habitat.

The sponge was found growing on stones, roots, branches of trees and living water-plants.

#### General Characteristics.

The sponge formed crusts of various thicknesses upon almost any available type of support. Sometimes outgrowths were formed from

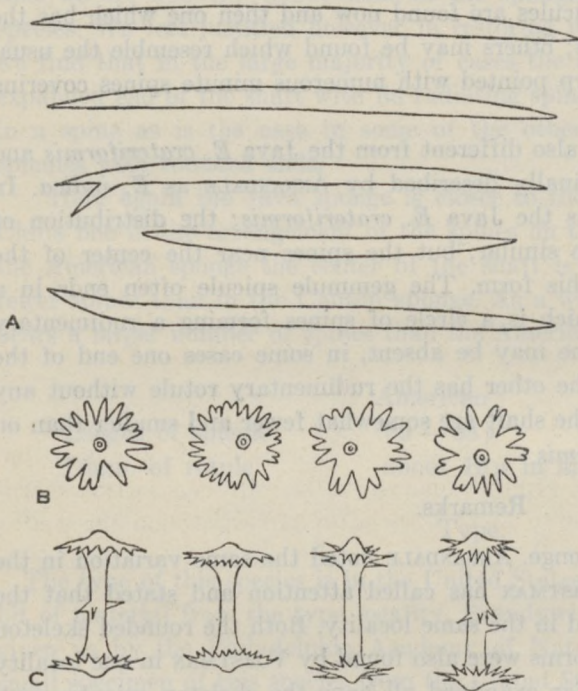


Fig. 9. *Ephydatia fluviatilis*

- a. Skeleton spicules.
- b. End view of rotules.
- c. Gemmule spicules.

these crusts and these took the form of ribbon-like bands. Some of the oscula were large. This sponge had developed extraordinarily in Lake Manindjau. In many places along its stony shores, the stones and wood were so abundantly covered with a thick cushion of it that bathers along these places were painfully pricked by the silicious spicules.



### Color.

The color of the sponge was a pale yellow when the algae were not present. The algae were usually especially abundant around the openings of the oscula and made the area immediately surrounding these openings deep green in color.

### Skeleton Spicules.

The skeleton spicules are long, smooth, slender, spindle-shaped, gradually and sharply pointed. They vary from 250 to 270  $\mu$  in length. We find the spicules of our specimen sometimes very finely spined and to average somewhat longer than the measurement given by WEBER, 264 to 326  $\mu$ .

### Flesh Spicules.

No flesh spicules are present in this species.

### Gemmules.

Sometimes the gemmules were found in groups often covering the substratum of the sponge with a layer which is more or less joined together at the base of a vigorously growing sponge colony. The gemmules were about 400  $\mu$  in diameter and brown in color. The gemmules are covered by a single layer of vertically placed amphidisks.

### Gemmule Spicules.

The gemmule spicules are birotulates or amphidisks. The shaft has a varying number of spines which often reach in length almost the diameter of the shaft. The two disks are of about the same size and strongly serrated, the incisions varying very much in size and depth. The length of the shaft normally is about 35 to 50  $\mu$ .

The shaft usually projects slightly beyond the disks forming small bud-like elevations. At times, however, abnormal spicules, as long as 80  $\mu$ , may be found; these have their ends projecting beyond the disks into long, heavy, sharp spines and their disks modified into a circle of heavy spines around the shaft.

### Type.

The type of this species is not known. WEBER's specimens are in the Amsterdam Museum. He has kindly sent us a small bit of this material but there are no gemmules present in the specimen.

### Distribution.

*E. fluviatilis* in some one or other of its forms is cosmopolitan in its distribution. It is common in Europe, in Eastern China and occurs in India, Australia, Japan, North America and South Africa.

### Remarks.

WEBER found his specimens to resemble *E. ramsayi* which he thought, with LENDENFELD, should be called a variety of *E. fluviatilis*. He found that his sponge could be distinguished from that one by the following characteristics:



1. That it has smooth, spindle shaped skeleton spicules while those of *ramsayi* are more cylindrical and abruptly pointed and have spines on them. They also measure only 220  $\mu$  in length as compared with the Java sponges 250 - 270  $\mu$ .
2. The gemmules measured 350  $\mu$  in diameter; those of the Java sponge were 400  $\mu$  in diameter.
3. The gemmule spicules are shorter averaging around 29  $\mu$  in length while those of the Java sponge were from 35 to 50  $\mu$  in length.

He found also that his sponge had a few gemmule spicules which had spiny shafts similar to those of *E. ramsayi* and that *E. ramsayi* had a few smooth sharply pointed skeleton spicules similar to those of *E. fluviatilis*.

ANNANDALE thought this sponge to be *E. meyeri* and in his volume of the Fauna of British India p. 110, 1911 wrote as follows concerning it: "*E. meyeri* is closely related to the two commonest Holarctic species of the genus, *E. fluviatilis* and *E. mülleri* which have been confused by several authors including PORTS. From *E. fluviatilis* it is distinguished by the possession of bubble cells in the parenchyma, and from *E. mülleri* by its invariably smooth skeleton spicules and the relatively long shafts of its gemmule-spicules. The latter character is a marked feature of the specimens from the Malay Archipelago assigned by Prof. MAX WEBER to *E. fluviatilis*. I am indebted to his kindness for an opportunity of examining some of them."

ANNANDALE states that while *E. fluviatilis* resembles in many respects *E. meyeri* that yet it differs from it in the following characters:

- „(1) There are no bubble cells in the parenchyma;
- (2) There is less spongin in the skeleton which is less compact;
- (3) The gemmule spicules are longer, the shafts being as a rule longer than the diameter of the rotules;
- (4) The gemmules are armed with a single row of regularly arranged spicules embedded in pneumatic tissue with minute air space."

Since we do not have any gemmules in the small bit of material which we have been able to examine and as there is no specimen representing this species in the collection made by Dr. VORSTMAN, we are not in a position to express any opinion upon the question and will await further gemmule bearing material from that same locality in order to reach a conclusion.

As *E. fluviatilis* is a very variable form and as the differences of the spicules are so slight, we are leaving WEBER's determination to stand for the present, but call attention to the uncertainty by the use of the question mark.

### **Ephydatia fortis** var. **vorstmani** nov. var.

#### Historical Statement.

The type of *Ephydatia fortis* was first described by WELTNER from the Philippine Islands in Spongillidenstudien III, Archiv für Naturg., p. 141, 1895, but unfortunately this description was not accompanied by illustrations.



The sponge at present under consideration was described by VORSTMAN from Ranoe Klakah, East Java, in *De Tropische Natuur* No. 7, p. 116, 1928, as *E. fluviatilis* var. *ramsayi*.

Through the kindness of Dr. W. ARNDT of the Berlin Zoological Museum, we have been able to compare the Java sponge with both *E. fortis* and *E. fluviatilis* var. *ramsayi* and have reached the conclusion, after a careful study of these and other materials, that the Java sponge is closer to *E. fortis* than to the var. *ramsayi*, but that the variations enumerated below entitle it to a varietal name. It gives us much pleasure to name this variety in honor of Dr. ADRIANA G. VORSTMAN who has so kindly made this collection of Java sponges which we have been privileged to study.

#### Habitat.

The Philippine Islands sponge was found on the leaves of *Vallisneria* in Libmanan River. The one Java specimen of this sponge was growing on the surface of a stone in the water.

#### General Characteristics.

According to VORSTMAN, the habit of growth of the sponge is to form solid, round, crust-shaped pieces with a diameter of 2 centimeters or more. The crusts are 1 to 2 cm.

thick and the surface is uneven being covered with rows and plaits formed by short protuberances which have grown together.

These unevennesses on the one specimen sent us are irregular ridges of varying height, the highest about one centimeter and arranged without any regular system or order. The oscula are located in the depressed areas between this ridges and are simple openings.

#### Color.

VORSTMAN notes that when dry specimens became very white. Our specimen is a light yellowish brown or straw color and appears as if it were taken from clean water, as it contains very little sediment of any kind.

#### Structure.

In a cross section of the sponge the vertical fibers, each consisting of

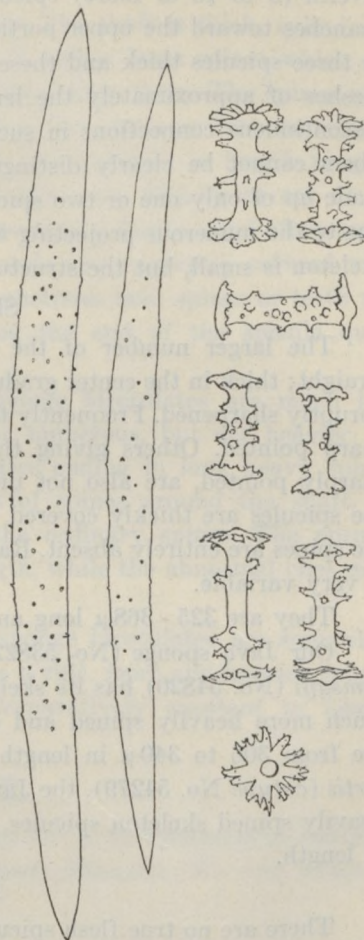


Fig. 10. Skeleton and gemmule spicules of *Ephydatia fortis* var. *vorstmani*.



several (3 to 10 or more) spicules, show up quite clearly sending off smaller branches toward the upper portion of the sponge. These branches are often two or three spicules thick and these, together with the main fibers, are woven into meshes of approximately the length of the spicules, by the rather short, thin, discontinuous connections in such a manner that a regular series of transverse fibers cannot be clearly distinguished. These cross connections are frequently made up of only one or two spicules. The upper surface of the sponge is hispid due to the numerous projecting tips of the fibers. The amount of spongin in the skeleton is small, but the structure is firm.

#### Skeleton Spicules.

The larger number of the skeleton spicules is gently curved, a few are straight; thick in the center gradually sloping to near their ends and then become abruptly sharpened. Frequently they are slightly smaller just before they become sharp pointed. Others giving the appearance of a spear head, gradually and sharply pointed, are also not uncommonly found in the preparations. Most of the spicules are thickly covered with small spines except near their ends where the spines are entirely absent. Rare spicules are smooth and the number of spines is very variable.

They are 325 - 368  $\mu$  long and 18 to 28  $\mu$  thick.

Our Java sponge (No. 53822) as compared with the Australian *Ephydatia ramsayi* (No. 54820) has its skeleton spicules of about the same length, thicker, much more heavily spined and differing in shape. The spicules of *E. ramsayi* are from 306 to 340  $\mu$  in length. As compared with the Philippine Islands *E. fortis* (cotype No. 54279), the Java sponge has slightly shorter thicker and more heavily spined skeleton spicules. In *E. fortis* the spicules are from 314 to 383  $\mu$  in length.

#### Flesh Spicules.

There are no true flesh spicules. In our specimen there are numerous minute spicules which we consider to be the very young skeleton spicules of the embryonic sponges developing within the parent colony.

#### Gemmules.

Our one Java specimen has only a few gemmules and these are located in groups of four or five on the bottom of the sponge. It looks as if in removing this sponge from its support a good deal of the basal membrane has been left behind and doubtless most of the gemmules remained attached to this membrane.

In color the gemmules are similar to the sponge, light straw-color.

The gemmules are spherical, or nearly so, and are covered by a single layer of birotulates arranged perpendicularly to the gemmule surface often with scattered spicules of a second layer found here and there over the surface of the gemmule. The first layer of gemmule spicules is altogether embedded in the granular coat while those of the second layer frequently have the outer end free. The pore-tube is simple and does not project beyond the surface of the granular coat.



### Gemmule Spicules.

The gemmule spicules are heavy birotulates. The shaft is thick, cylindrical and spined, bearing from 2 or 3 up to 10 or 15 rather large spines which are themselves often subdivided or bear smaller spines upon them. The spines may reach a length equal to one half the diameter of the rotule or may be simple, very short granules on the shaft. The spicules are variable in length ranging from 38 to 64  $\mu$ . The shaft as a rule projects only very slightly or not at all beyond the rotule. The disks are deeply and irregularly dentate and often reach a diameter of 25  $\mu$  or more. The teeth of the rotule are frequently covered with small spines or minute rounded granules and sometimes bear spines or teeth not in the same plane as the rotule, thus making the end of the spicule quite irregular in appearance.

As compared with *E. fortis*, the Java sponge birotulates are much less variable in length, their shafts' spines are less numerous, but are heavier. *E. fortis* also has a number of abnormal birotulates ending in long heavy spines and often the rotules are reduced to a series of spines around the shaft, or they may not even be distinguishable from the ordinary spines. The normal spicules of *E. fortis* vary from 46 to 64  $\mu$  in length, while the abnormal ones may reach a length of 136  $\mu$ .

As compared with *E. ramsayi*, the Java sponge birotulates are somewhat more variable in length, are thicker and bear, as a rule, more and heavier spines. The gemmule spicules of *E. ramsayi* are comparatively constant in length varying from 36 to 44  $\mu$ .

### Type.

The type of this new variety was collected by Dr. A. G. VORSTMAN in September, 1927, and will be preserved in the Buitenzorg Museum. We will retain a *cotype* in our collection.

### Distribution.

This sponge was collected at Rawah Klakah, Pasoeroean, East Java. It was found in only this one place and is the only specimen in the collection sent us from Java.

### Remarks.

In making a study of this sponge we have been able to compare it with the following series of somewhat related forms from widely separated areas:

*E. fortis* from the Philippine Islands; *E. fortis* var. *hebridensis* from the New Hebrides Islands.

*E. subdivisa* from the United States of America; *E. facunda* from Brazil.

*E. ramsayi* from New Zealand, and *E. fluvialis* var. *syriaca* from Syria.

We have already given above the comparison with *E. ramsayi* and with *E. fortis* and will add below similar comparisons with the other forms:

As compared with the Java sponge,



*E. subdivisa* from Florida (No. 54292) has shorter, thinner skeleton spicules with fewer but comparatively larger spines. Spicules measure from 221-280  $\mu$  in length.

The gemmule spicules are thinner, have fewer spines and are more variable in length, they are from 36 to 62  $\mu$  long.

*E. facunda* from Brazil (No. 54288) has thinner, gradually, and sharply pointed skeleton spicules which are often smooth; when spines are present they are fewer and smaller than those of the Java sponge; length of spicule 323-374  $\mu$ .

The gemmule spicules are thinner in shaft, usually the spines are simple and very sharp, though some of them sometimes bear smaller spines upon the larger ones. They are a little shorter than the Java sponge. They measure 34-50  $\mu$  in length.

*E. fluviatilis* var. *syriaca* from Syria (No. 53016) has shorter, smooth skeleton spicules, rarely very finely granulated ones are present. They measure from 255 to 300  $\mu$  in length.

The gemmule spicules are shorter, more uniform in length, about 34  $\mu$ , smaller and bear fewer spines on their shafts.

*E. fortis* var. *hebridensis* from the New Hebrides (Nos. 53794 and 53797) varies quite a great deal, No. 53797 has skeleton spicules from 229-289  $\mu$  in length and with comparatively small spines.

The gemmule spicules vary from 44 to 76  $\mu$  in length and some of them ending in long sharp spines are even up to 120  $\mu$  in length. Some have shafts free of spines while others bear numerous spines.

No. 53794 has much heavier and larger skeleton spicules, measuring from 298 to 383  $\mu$  in length, and the spines vary from granulations over the central area to very long heavy spines which may in some cases even be as long as the diameter of the thick spicules itself.

After these comparisons we have reached the conclusion that the Java sponge most closely resembles *E. fortis* of the Philippine Islands, but that it varies from that form enough to entitle it to a varietal name.

### **Trochospongilla latouchiana** ANNANDALE, 1907.

#### Historical Statement.

This sponge was first described in 1907 from Calcutta, India, by Dr. N. ANNANDALE in the Journal and Proceedings of the Asiatic Society of Bengal (new series) Vol. 3, No. 1, pp. 21-22, fig. 5. Again in 1911 in his contribution to the Fauna of British India, he redescribed it (p. 115, fig. 24) and gave its known distribution in India up to that time. In 1918, he identified some specimens, sent to him by the writer from Soochow, China, as belonging to this species and published his findings in the Memoirs of the Asiatic Society of Bengal, Vol. 6, p. 205. Later on after more careful study of this Soochow material,



Dr. ANNANDALE decided that it varied from the typical form and called it *T. latouchiana* subspecies *sinensis* in the Records of the Indian Museum, Vol. 16, Pt. 7, pp. 457-458, 1919.

After Dr. ANNANDALE's death the writer began the study of the Soochow material as a hobby during such free time as he could find from his regular duties and found that both the type form and the subspecific form were quite common in and around Soochow and also in a number of other places in Kiangsu and Chekiang Provinces in China. This observation was recorded in the Lingnaam Agricultural Review, Vol. 4, No. 2, p. 185 in 1927, and later in the same year was again published in a key to the Chinese fresh-water Sponges as Part 1 of Bull. No. 2 of the Peking Society of Natural History.

In 1927 Dr. A. G. VORSTMAN published upon the result of her findings in Java and reported this species to occur in several localities

there. Her paper was published in de Tropische Natuur No. 11, p. 184. Up to the present this sponge in its typical form is known from India, East Central China and Java.

#### Habitat.

In India its favorite place of growth seems to be in the „tanks” where it forms a thin crust covering various kinds of supports, often on plants. .

Our China specimens were in almost every case taken from the nearly smooth surfaces of the stones used as bunding for the canals or from the piles supporting this stonework or other structures along the canal banks. While many of the specimens from Nanking and Kashing are very thin yet some of the Soochow specimens are near a centimeter in thickness. Most of these thicker specimens are of the variation from the type form, though often both the longer and shorter disked gemmule spicules are present in the same preparation from this material. In the canal in Soochow which the largest number of sponges were taken, there is a slight current most of the time and at times during the rainy season — spring and summer — the current becomes strong.

In Java it was taken from ponds and lakes and the specimens sent us by

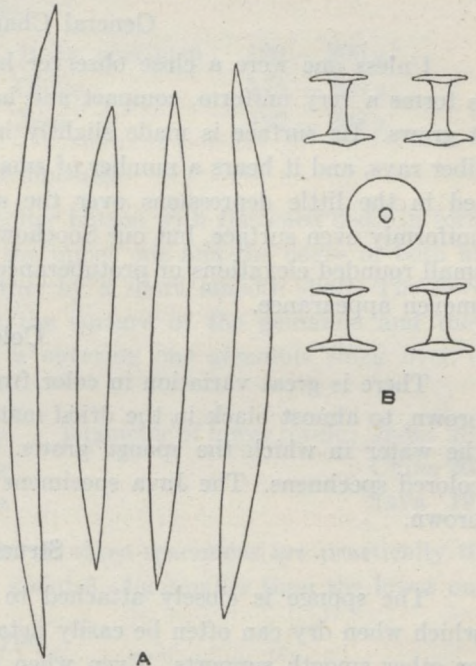


Fig. 11. *Trochospongilla latouchiana*  
a. Skeleton spicules.  
b. Gemmule spicules.



Dr. VORSTMAN are all upon leaves or twigs of plants which are entirely covered by a thin growth of the sponge.

#### General Characteristics.

Unless one were a close observer he would be to overlook this sponge as it forms a very uniform, compact and hard cover over the support upon which it grows. Its surface is made slightly hispid by the projection of the vertical fiber rays, and it bears a number of small, inconspicuous oscula which are located in the little depressions over the sponge. The Java specimens present a uniformly even surface, but our Soochow materials are quite often covered with small rounded elevations or protuberances which give the surface a more or less uneven appearance.

#### Color.

There is great variation in color from a grayish, through various shades of brown, to almost black in the dried material. The color seems to depend upon the water in which the sponge grows, the cleaner waters yielding the lighter colored specimens. The Java specimens are of varying shades of gray or dark brown.

#### Structure.

The sponge is closely attached to its support by a chitinous membrane which when dry can often be easily detached from the smooth surface of stones or other smooth supports. Even when entirely surrounding a twig the sponge can usually be loosened and removed when it dries out.

The skeleton is very compact and hard though it is easily crumbled. The vertical radiating fibers are made up of several spicules tightly bound together by horny material. These vertical fibers are solidly bound together by transverse fibers of fewer spicules, so that the whole skeleton forms a very firm network.

#### Skeleton Spicules.

The skeleton spicules are usually straight or gently curved spindle-shaped, gradually and sharply pointed at both ends and are altogether smooth. There is considerable variation in the dimensions of these spicules and while they are as a rule quite regular in general outline yet at times very irregular or abnormal ones may be found in the preparations. We give below a table of the dimensions of the skeleton spicules from specimens from India, China and Java:

	India cotype (No. 53724), Java (No. 53707), China (No. 165)		
Length of spicules	248 — 320 $\mu$	196 — 230 $\mu$	220 — 248 $\mu$
Thickness of spicules	12 — 17 $\mu$	10 — 16 $\mu$	8 — 16 $\mu$

#### Flesh Spicules.

There are no flesh spicules in this species.

#### Gemmules.

The gemmules occur singly, are small, and when dry are white in color. They are very numerous and are scattered throughout all parts of the sponge.



being held in position by the network of spicules. There is a single simple pore-tube which often forms a crater-like elevation above the single layer of spicules which completely envelops the gemmule.

Diameter of the gemmules, India specimen	180 — 200 $\mu$ .
China „	176 — 200 $\mu$ .
Java „	192 — 208 $\mu$ .

#### Gemmule Spicules.

The gemmule spicules resemble a collar button with flattened disks in form. The lower disk is slightly larger than the upper one and the edges of both are smooth. The two disks are joined together by a short, smooth shaft. The lower disks of the spicules are placed upon the surface of the gemmule and they, embedded in a protective layer, form a covering one gemmule thick over its entire surface.

Length of gemmule spicules: India 17 $\mu$ .	Diameter of lower rotule: India 20 $\mu$ .
China 16 $\mu$ .	China 20 $\mu$ .
Java 16 $\mu$ .	Java 19 $\mu$ .

The dimensions of these spicules in all three specimens are practically the same. The upper rotule in each case is about 3 - 4  $\mu$  smaller than the lower one.

#### Type.

The type of this species is in the Indian Museum in Calcutta. Through the kindness of the authorities of that Museum we have a small *cotype* in our collection.

#### Distribution.

- Java: (1) Ponds in the Botanical Garden, (2) Lake near the stopping place of Tjitajam, (3) Rawah Galapan, Kali Tjampoerdarat (South Kediri).  
 China: (1) Soochow, (2) Nanking, both in Kiangsu Province; (3) Kashing, Chekiang Province.  
 India: Calcutta and neighborhood.  
 Burma: Kawkareik, Amherst District, Tenasserim.

#### Remarks.

The numerous China specimens of this sponge in our collection represent the type form as described above and also the variety, *S. latouchiana* var. *sinensis*, with birotulates having a longer shaft and being somewhat larger in general proportions than the type form. It is at times difficult to determine where to place some of these sponges. The type form and the variety can be easily separated when only one or the other is present but there are many specimens which appear to be intermediate ones and bear birotulates which seem to connect up these two extremes. This fact raises the question as to whether or not ANNANDALE'S variety should stand.



***Trochospongilla tunghuensis* var. *javanensis* nov. var.**

## Historical Statement.

*Trochospongilla tunghuensis* was briefly described and illustrated by the writer in the China Journal of Science and Arts, Vol. 4, No. 4, p. 183, fig. 5, 1926. It was compared with *Trochospongilla phillottiana* of India, and it was pointed out that both the skeleton spicules and the gemmule spicules of *T. tunghuensis* were considerably larger than those of that species and that the gemmule spicules of the two species also differed somewhat in structure.

Dr. VORSTMAN has designated the *Trochospongilla* which she collected in Rawah Bening, Java, in September 19, 1927 as *T. phillottiana*, but it resembles much more closely the China form named above than it does the Indian sponge; yet at the same time we think it differs sufficiently from

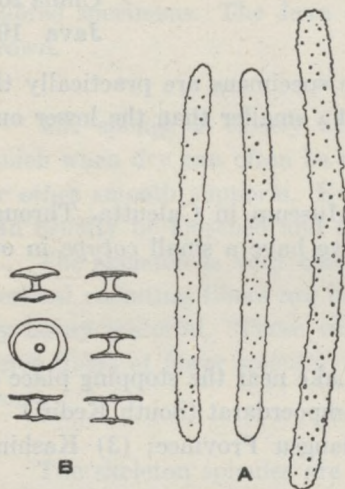


Fig. 12. *Trochospongilla phillottiana*, India species.  
a. Skeleton spicules.  
b. Gemmule spicules.

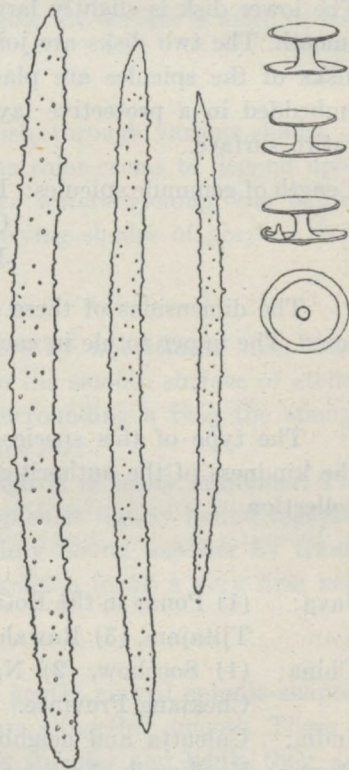


Fig. 13. *Trochospongilla tunghuensis*, China species.

*T. tunghuensis* to deserve a varietal name and we propose *javanensis* as an appropriate name for the variety.

It is interesting in this connection that we found in Lake Biwa in Japan in November 1926, a few gemmules of a sponge so closely resembling our *T. tunghuensis* from China that it must be called the same species.

## Habitat.

The Java sponge forms very minute patches, with a skeleton just thick enough to cover a few gemmules, on the small rootlets of trees. These rootlets were evidently hanging freely in the water in Rawah Bening, South Kediri.



## CORRIGENDUM.

### REVISION OF NOMENCLATURE.

We have just secured a *cotype* of *Trochospongilla phillottiana* from the Indian Museum through the kindness of Colonel SEWELL of the Indian Museum, and find it to be a sponge with much larger spicules than the three other specimens which were previously sent to us labeled as *T. phillottiana* by Dr. ANNANDALE. The *cotype* was taken from the Museum tank in Calcutta. The three other earlier specimens which we have are all from the same locality, Kawkareik, Lower Burma.

It now becomes clear that the Kawkareik sponge which we have been accepting as the typical form, is an undescribed one, very closely resembling *T. phillottiana* in the general appearance of its spicules, but is considerably smaller than the *type* form. We now propose to name this *T. phillottiana* var. *minima* and we have under preparation a restudy of all these related forms of *Trochospongilla*.

It would seem now that the Java, China and Japan sponges are more closely related to the typical form of *T. phillottiana* than we had realized and we propose the following changes in the names given in our article on the fresh-water sponges of the Dutch East Indies:

*T. tunghuensis* should probably become *T. phillottiana* var. *tunghuensis*

*T. tunghuensis* var. *javanensis* should probably become *T. phillottiana*  
var. *javanensis*

and we would create as a new variety, *T. phillottiana* var. *minima*, the Kawkareik sponge which was sent to us as *T. phillottiana* and which is responsible for this confusion.

We are now having accurate drawings of all of these forms prepared and will soon present to the Indian Museum a fully illustrated paper clearing up this problem of relationships of the above sponges.

N. GIST GEE.

Peiping, China  
May 6, 1930.

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The China representative of this species has been found in Tung Hu (East Lake), near Ningpo, Chekiang Province; in Soochow and in Nanking. In each case there were only a few gemmules and minute bits of a skeleton present. In Ningpo the bits of sponge were found among the algal growth on a stone below the water gates which controlled the level of the water in the lake in order that it might be used in irrigation. The water poured over these gates during the growing season of the sponge and kept it covered with water. The spicules of this sponge from Soochow and the one from Nanking were found after the slides were prepared and consisted of only a few spicules mixed with those of other species. The sponge itself was not observed. Even when mature the sponge must be a very small one.

#### Color.

The little colonies of the Java sponge are a light gray, tinged with yellow or cream color.

#### Structure.

The skeleton of the sponge is not much more than a lot of small, loosely formed meshes around the few gemmules. The meshes are very fragile and even in handling the rootlets on which the sponges grew the gemmules are easily dislodged and fall away. The amount of spongin is small and the skeletal fibers are slender, being usually made up of only two or three spicules. In a few colonies the remains of a very thin external membrane can still be seen, though in most of them this has been broken off through the handling of the specimens.

#### Skeleton Spicules.

The skeleton spicules of the Java variety are usually slightly curved, though straight ones are found now and then. They are rounded at both ends and are of a nearly equal diameter throughout their entire length. They are entirely and thickly covered with minute perpendicular spines which become more numerous and smaller at the ends of the spicule.

The following table of measurements is given for the purpose of comparing the dimensions of the spicules of the four related sponges:

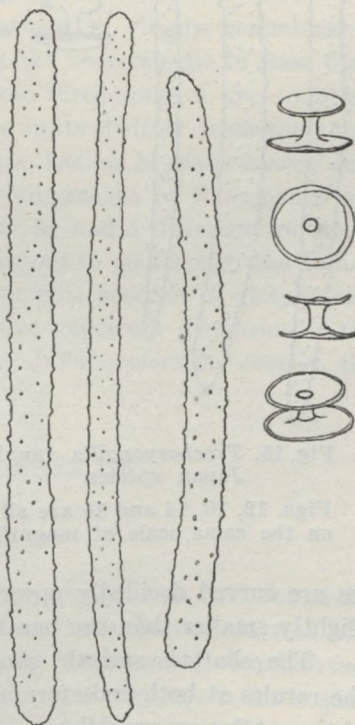


Fig. 14. *Trochospongilla tung-huensis* var. *javanensis* Java species.



	<i>T. phillottiana</i> India	<i>Trochospongilla tunghuensis</i> China	Japan	Java
Length of skeleton spicules	98-119 $\mu$ .	146-160 $\mu$ .	140-156 $\mu$ .	150-190 $\mu$ .
Diameter of thickness of skeleton spicules	8 $\mu$ .	7-10 $\mu$ .	8 $\mu$ .	12-14 $\mu$ .

These measurements show the Java sponge to average somewhat longer and thicker than the sponges from China and Japan and to be considerably heavier than those of *T. phillottiana* of India. In the China and Japan sponges also, there is frequently a tapering toward the ends of spicules and some of them are even bluntly pointed; this condition is not found in the Java sponge.

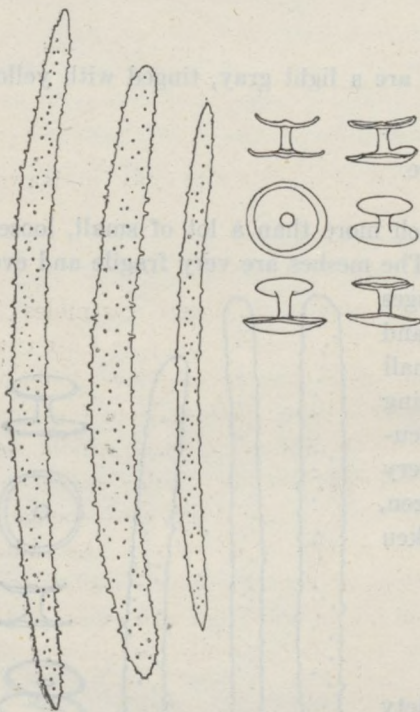


Fig. 15. *Trochospongilla tunghuensis*  
Japan species.

Figs. 12, 13, 14 and 15 are all drawn on the same scale of magnification.

les are curved decidedly upward forming saucer-like disks. The outer rotule is slightly smaller than the basal one and possibly also slightly more curved.

The shaft is smooth, short and thick and projects very slightly beyond the rotules at both ends forming extremely small rounded elevations. The edges of the rotules are smooth.

For the sake of comparing the dimensions we give the following table of measurements:

#### Flesh Spicules.

No flesh spicules were found in any of these sponges.

#### Gemmules.

The white gemmules are numerous for the size of the sponge colony.

In the dry sponges the upper half of the gemmule has sunk down in almost every case and the dried gemmule resembles a small bowl in shape. The thin outer layer of membrane covering of the gemmule joins with the outer rotule of the gemmule spicules making minute depressions or pits all over its surface. The spicules, with their basal rotule resting upon the gemmule, form a single layer covering it. The diameter of the gemmule is from about 255 to 300  $\mu$ .

#### Gemmule Spicules.

The gemmule spicules have the general structure characteristic of the genus *Trochospongilla*, but the outer edges of both the upper and lower rotu-



	<i>T. phillottiana</i>	<i>T. tunghuensis</i>		<i>T. tunghuensis</i> var. <i>javanensis</i>
	India	China	Japan	Java
Length of spicules	7—8 $\mu$	10 $\mu$	12 $\mu$	12 $\mu$
Diameter of larger rotule	13—14 $\mu$	18—22 $\mu$	20 $\mu$	22 $\mu$

The dimension of *T. phillottiana* and *T. tunghuensis* here again are quite distinct, but the gemmule spicules of the China, Japan and Java representatives are much more alike than those of the skeleton. The spicules of the Java sponge probably average a little larger than those of the China and the Japan representative of this species.

#### Type.

The type of this new variety is deposited in the Zoological Museum at Buitenzorg, Java. We are retaining a *cotype* in our collection.

#### Distribution.

This new variety has, up to the present, been collected only in Rawah Bening (South Kediri) in East Java.

#### Remarks.

It is of special interest that this Java sponge so closely resembles *T. tunghuensis* which has been found both in East Lake near Ningpo in East Central China and in Lake Biwa, Japan. While these three sponges are doubtless all related to *T. phillottiana*, yet we think them quite distinct from the small *cotype* of that species which Dr. ANNANDALE of the Indian Museum kindly sent us several years ago. His measurements of the dimensions of this sponge are considerably larger than ours, and it may be that he had a different sponge in hand from the *cotype* sent us. It would be interesting to go through the Indian Museum collection to discover if this were true or not; possibly *T. tunghuensis* also exists in India. For the reasons given above under our discussion of the skeleton and gemmule spicules, we believe this Java sponge to deserve the varietal name which we have given it.

### ***Tubella vesparium* VON MARTENS, 1868.**

#### Historical Statement.

This very interesting and unique fresh-water sponge was first found by Dr. HUNJUS in the Kapuas River at Sintang in northern Borneo. It was also found further up the river in Lake Danau Sring on the branches of a *Barringtonia* tree in May 1863 when the water of the lake was very much lower than usual. It was fully described and illustrated by E. VON MARTENS in WIEGMANN'S Archiv für Naturgeschichte Jahrgang 34, Band 1/2, pp. 61-64, in 1868. It is strange that both CARTER (1881) and POTTS (1887) in publishing the descriptions



of known sponges up to those dates should have overlooked this sponge. WEBER in his work on the East Indian fresh-water sponges, Zool. Ergebn. einer Reise in Niederl. Ost Indien Vol. I, p. 45, 1890, calls attention to the occurrence of this sponge in Borneo. Through the kindness of Dr. W. ARNDT of the Berlin Museum we have a small bit, the *cotype*, of this sponge and we give the following description partly as a translation from VON MARTENS' article and partly from the specimen in hand.

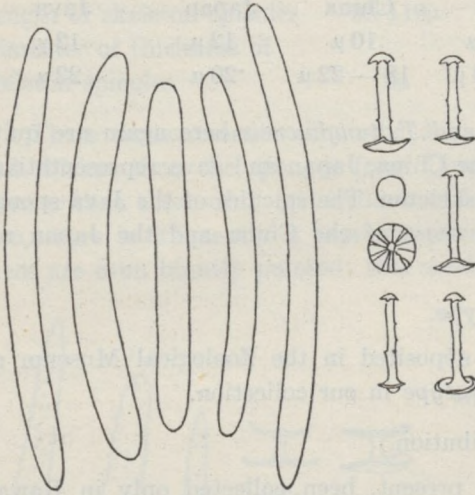


Fig. 16. Gemmule and skeleton spicules of *Tubella vesparium*.

#### Habitat.

*T. vesparium* was found around the stems of plants which had been submerged during the time of high water but at the time it was collected the plants were several feet above the

water level. The small piece in our collection has a hole in the center of it where the stem upon which it had grown was removed.

#### General Characteristics.

At first the masses of sponge as big as one's fist around the thin branches of trees, were taken by the observers to be wasps' nests but closer examination revealed the fact that they were sponges. Usually the sponge was quite symmetrical, forming a mass thickest in the middle and tapering toward the support at both ends (Fig. 17). Sometimes the sponge united two branches or otherwise grew into irregular shapes. When dry the sponge is very hard and has many sharp pointed projections all over its surface. The surface is rough like knitting and the little depressions are from 3 to 5 millimeters. On each

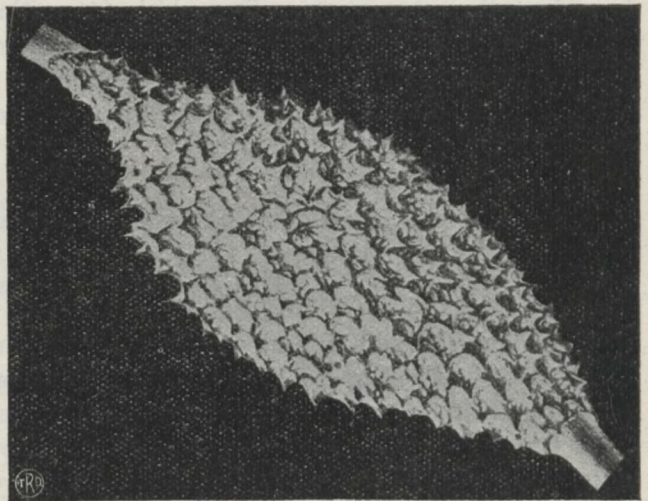


Fig. 17 Photograph of a sponge after VON MARTENS.



point there are single or divided projections about 4 millimeters high. Close examination reveals the fact that each of the larger depressions in the surface is further subdivided into similar divisions. Where the sponge was attached to the branch of the tree, however, the surface next to the support formed a very smooth continuous membrane and when dry it could easily be slipped from its support.

#### Color.

When dry the sponge has a dark grayish brown, almost black, color.

#### Structure.

The radial fibers, which grow out perpendicularly from the support, are very thick and strong. They are broader at the base and become thinner toward the outer surface of the sponge and extend in points beyond the surface. Thinner, more irregular transverse fibers bind these radial ones together making a very firm and compact structure. Spongin is abundant. It is quite different from most of the fresh-water sponges with which we are familiar and looks much like a fibrous woody material.

#### Skeleton Spicules.

The skeleton spicules are curved, perfectly smooth and have bluntly rounded ends. As a rule they are of very nearly uniform thickness throughout their entire length. VON MARTENS found that they measured from 180 to 220  $\mu$  long and from 10 to 15  $\mu$  in thickness. Our measurements confirm his in the main but show a slightly wider variation. We find them to vary from 156 to 210  $\mu$  in length and from 10 to 16  $\mu$  in diameter.

#### Flesh Spicules.

We find no flesh spicules in this sponge.

#### Gemmules.

The gemmules are large, spherical, almost black in color and are widely scattered through the skeleton, not being confined to any special part of the sponge. They occur singly and are firmly held in position by spongin and are not easily dislodged. They are large in size, measuring 666  $\mu$  in diameter.

#### Gemmule Spicules.

The gemmules are amphidisks with unequal disks. The inner disk is several times as large as the outer one. It is circular often with slight radial or concentric circular markings made by the thickening of the disk. The edges of this disk are generally smooth but at times they may become somewhat scalloped between the thickened radii which run out the base of the shaft. VON MARTENS states that the small outer disks are also smooth but we find that most of them bear 5 to 7 short spines which have their ends turned inward toward the shaft. Now and then, however, smooth rounded button-like disks are found.

The shaft is thicker at the base and becomes thinner toward its upper end. It usually bears a few spines, most of which occur on the lower half, but they are not altogether absent from the upper half of the shaft.



VON MARTENS records them as measuring from 40 to 50  $\mu$  in length and the shaft as being about 3  $\mu$  thick. Our measurements make them slightly shorter from 30 to 40  $\mu$  in length, the outer disk 5 to 8  $\mu$  and the basal one about 20  $\mu$ .

#### Type.

The type of this sponge is preserved in the University Zoological Museum in Berlin. We have a small *cotype* in our collection.

#### Distribution.

So far as we have been able to learn, this sponge has been found only in northern Borneo in the Kapuas River and in Lake Danau Sring. We can find no record of its having been collected there at a later date than 1863 and it would be interesting to have an opportunity to study fresh material from that locality.

#### Remarks.

Several sponges of this genus have been found in other parts of the world. BOWERBANK described *Tubella* (*Spongilla*) *reticulata* from the Amazon River in 1863 and CARTER described another sponge with similar gemmule spicules as *Tubella spinata* in 1881; this sponge also came from the Amazon River. Two other related forms *T. paulula* and *T. recurvata*, which do not so closely resemble the Borneo sponge, have been described from America and one called *Tubella nigra* (which may be an *Ephydatia*) from Australia. WEBER states that this sponge, *T. nigra*, also occurs in Borneo, but it seems likely that he meant *T. vesparium*. ANNANDALE describes *T. vesparioides* from India; this sponge resembles *T. vesparium* but the basal disk of the Indian sponge is denticulated. In 1895 WELTNER described another form, *S. pottsii*, from the Congo in Africa.

### ***Nudospongilla sarasinorum* (WELTNER) 1901.**

#### Historical Statement.

This sponge was found in Towuti Lake, Loëha Island, Celebes by SARASIN on March 2nd, 1896. It was described and illustrated by WELTNER in his *Spongillidenstudien IV*, Archiv für Naturg. p. 196 et seq. in

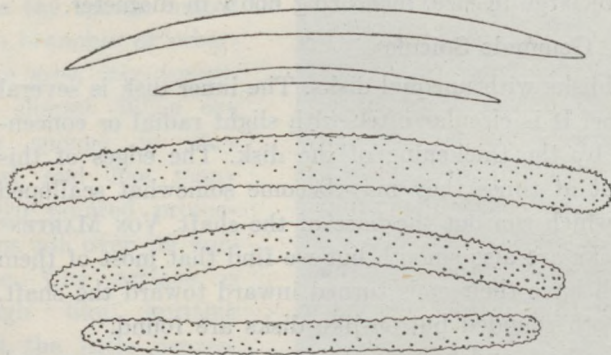


Fig. 18. The two different kinds of skeleton spicules of *N. sarasinorum*.

1901 as *Spongilla* (?) *sarasinorum*. So far as we can learn this sponge has not been found elsewhere and the above reference is the only description available. Through the kindness of Dr. W. ARNDT of the Berlin Zoological Museum we have had an opportunity to examine some of WELTNER's original preparations. Since



the gemmules were lacking, it is difficult to place this sponge generically with certainty, though ANNANDALE thought it belonged in his genus *Nudospongilla*. We are accepting his classification of it. We give below much of the substance of WELTNER's original description adding our observations upon such material as we have had an opportunity to examine.

#### Habitat.

The sponge was growing on the surface of stones in still water in the lake.

#### General Characteristics.

The sponge was found forming thin crusts of from 1 to 2 centimeter in thickness, on stones. Its upper surface is smooth.

#### Color.

Often where it was exposed to light, the development of algae gave it a green color. In other locations it brown.

#### Structure.

The sponge forms a firm mass made up of the rod-like spicules, rounded at both ends, which are arranged parallel with each other at the base of the sponge. Often, however, these spicules become somewhat irregularly arranged forming a tangle at the base of the structure. From this irregular tangle rise the fiber bundles consisting of an indefinite number (5 - 8) of spicules. These spread out somewhat like a fan toward the outer surface of the sponge and often consist of from 4 to 10 spicules. The transverse fibres are also quite rare and variable and are much smaller and more irregular than the main ones. WELTNER thought his specimens were immature and that these connecting transverse fibers would be formed later as the sponge reached its maturity. The amount of spongin is small.

#### Skeleton Spicules.

The skeleton spicules are of two different types:

(1) There are slender, slightly curved, perfectly smooth, gradually and sharply pointed spicules, amphioxi, which average around  $180\ \mu$  long and  $8\ \mu$  in thickness. These occur chiefly in the basal part of the thin sponge crust.

(2) The spicules of the other type are amphistrongyli and are larger and heavier and make up most of the skeletal structure. These have rounded ends, are gently curved and are entirely covered with fine spines. Some of them are of about uniform thickness throughout their entire length, others are thicker in the center and taper toward their ends until the rounded ends are much thinner than their centers. There is also a good deal of variation in the length of these spicules. The average length is around  $190\ \mu$  but they vary from  $160\ \mu$  to  $210\ \mu$  in length. They average about  $18\ \mu$  in thickness but may often vary from 13 to  $20\ \mu$  in diameter.

Abnormal spicules occur abundantly in the preparations.

WELTNER states that on account of the form and size of the skeletal spicules



and the structure of the sponge, both of which are quite unlike any other known sponge, he considered this a new species.

#### Flesh Spicules.

No flesh spicules were found in the sponge.

#### Gemmules.

No gemmules were found in this sponge.

#### Type.

The type is in the Berlin Zoological Museum.

#### Distribution.

Up to the present time it has been reported only from the original locality where it was first collected — Towuti Lake, Loëha Island, Celebes.

#### Remarks.

The original description gives some interesting observations concerning the structure of the parenchyma of this sponge.

The author of the species also makes the following comparisons of this sponge with others containing similar kinds of spicules in the skeleton.

*Uruguaya macandrewsi* HINDE, 1888, from Paraguay has rough amphistrongyli and smooth amphioxi. Neither of these is identical in measurements with those of the Towuti Lake sponge.

*Uruguaya amazonica* WELTNER, 1895, from the Amazon River, has spicules of about the same size as the Towuti Lake sponge but its amphistrongyli are smooth and there are also other smooth, curved, spindle-shaped spicules with slightly rounded ends which do not occur in the Towuti Lake sponge.

*Potamolepis chartaria* MARSHALL, 1883, from the Congo has smooth amphistrongyli and amphioxi which form a dermal layer and are up to 80  $\mu$  in length.

*Parmula cristata* WELTNER, 1895, from Brazil has smooth amphistrongyli and rough amphioxi which are quite different in size from *N. sarasinorum*.

*Lubomirskia bacillifera* DYBOWSKI, 1880, from Lake Baikal has amphistrongyli which have considerable size. It has much larger spines than those of the Towuti Lake sponge.

### **Nudospongilla vasta** (WELTNER) 1909.

#### Historical Statement.

*Nudospongilla vasta* was collected by SARASIN on the same date and at the same place as *N. sarasinorum* and it was described in the same publication L1. E. No gemmules were found, and WELTNER called this *Spongilla* (?) *vasta* on account of the unusually large proportions of the skeleton spicules. We follow WELTNER's description.



### Habitat.

This sponge was also taken from the surface of rocks in Lake Towuti.

### General Characteristics.

It was forming a thin crust on rocks. The exposed surface was smooth.

### Color.

The color was about the same as that of *N. sarasinorum*;

green when exposed to light or brown in shaded places.

### Structure.

The spicules are more abundant in the basal portion of the sponge. They are not arranged into any definite structure but in the upper portion of the sponge there is a clearer net-work formation. The whole sponge has a very irregular structure. The spicule fibers originate from near the base of the sponge and are usually perpendicular to it. They are often of the same thickness throughout their entire length, the smaller ones having 2 to 4 spicules and the heavier ones as 4 to 8 spicules. The intersecting fibers may be found arising either perpendicularly or obliquely to the main fibers and they form irregular polygonal meshes. These transverse fibers are frequently just as thick as the main ones.

### Skeleton Spicules.

The skeleton is made up of only one kind of spicules. They are as a rule slightly curved a few are straight, and usually rather abruptly sharp-pointed. They are unusually large and thick and are covered with very fine spines throughout their full length. While the spines are generally more or less uniformly distributed over the surface of the spicules even to the ends, yet they may rarely be fewer in number or even lacking on the ends of some few spicules. The spines are so small as compared with the size of the spicule that they have the appearance of very minute granulations. The large axial canals are visible in many of the spicules. The size of the spicules justify the name *vasta*. They average around 370  $\mu$  in length and about 35  $\mu$  in diameter.

### Flesh Spicules.

WELTNER describes certain smaller spined and pointed spicules crowded around the oval shaped larvae. They resemble very closely the larger skeleton spicules and we are inclined to consider these as young or immature skeleton spicules and not flesh or gemmule spicules. The preparations which we have examined do not contain any of these spicules.

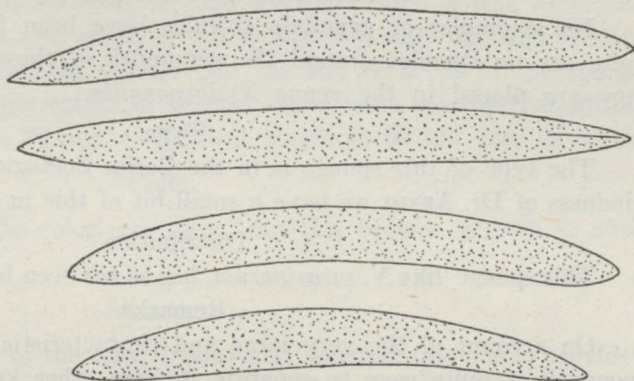


Fig. 19. The skeleton spicules of *N. vasta*.



### Gemmules and Gemmule Spicules.

No gemmules or gemmule spicules have been found. It is thought that there are no spicules around the gemmules of these two sponges and hence they are placed in the genus *Nudospongilla*.

### Type.

The type of this sponge is in the Berlin Zoological Museum. Through the kindness of Dr. ARNDT we have a small bit of this in our collection.

### Distribution.

This sponge, like *N. sarasinorum*, has so far been found only in Towuti Lake.

### Remarks.

On account of the very large and characteristic skeleton spicules of this sponge it is quite easy to separate it from other known species.

## ***Pachydictyum globosum* WELTNER, 1901.**

### Historical Statement.

*Pachydictyum globosum* is the name given to a sponge collected by Messrs. PAUL and FRITZ SARASIN on the banks of Posso Lake in Celebes in the middle of February 1895. This species was described and illustrated in 1901 by WELTNER in his *Spongillidenstudien* IV, in *Archiv für Naturg.* pp. 187-196. As he did not find his sponge similar to any other known ones, he created a new genus using this species as the type.

Our brief description below is condensed from the lengthy and detailed one given by the author of the species in the reference stated above.

### Habitat.

Five specimens were collected, all of them were found growing on fresh-water molluscs occurring in the Lake. Three of the specimens were

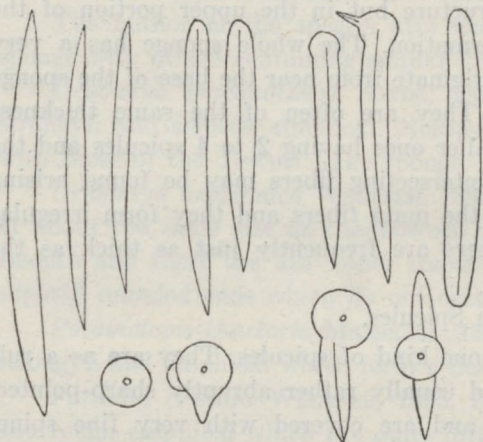
Fig. 20. After WELTNER.

The various types of skeleton spicules were found by WELTNER in the parenchyma of *Pachydictyum globosum*.

growing on *Melania kuli* SARASIN, one on *Melania centaurus* SARASIN, and a fifth one on *Miratesta celebensis* var. *robusta* SARASIN. It was observed that when the sponge was removed from the shell that evidences of corrosion over the part covered were plainly visible and it was thought that this was caused by some secretion from the sponge.

### General Characteristics.

The oscula of these sponges were turned away from the direction of the motion of the mollusc; probably this lessened the strain upon the ciliated chambers within the sponge.





Only one osculum was observed in each sponge, though it was concluded that on account of the size and shape of the sponge that only one was needed; doubtless more would have been formed had the size or needs of the sponge demanded them. The sponge varied in general shape from spherical to elliptical. They were from 31 to 32 mm. in greatest length to 20 - 25 mm. in width.

#### Color.

In living specimens the color was green, but this became grayish in 95% alcohol.

#### Structure.

In contrast with most of the other fresh-water sponges, this one is provided with a large cloacal cavity with which the osculum communicates through a hollow, broad barrel-shaped, or gradually inwardly widened opening. The body of the sponge may be from 3.5 mm. to 10 mm. in thickness varying with the size of the inner cavity.

The spicules of the various kinds described below are bound together in bundles of various thicknesses to form a firm skeletal framework. The ends of these fibers spread out in the upper surface into brush-like formations. The fibers vary a great deal, having from 6 or 8 to as many as 35 or 40 spicules. The transverse or bridge fibers often originate at acute angles from the main fibers and are thinner in structure, sometimes having as few as one or two spicules in them. This happens when the distances between the main fibers are small; longer distances between the fibers are bridged by heavier transverse fibers often having 6 to 10 or more spicules in them. Toward the upper surface the number of main fibers increases.

The spongin is poorly developed.

#### Skeleton Spicules.

The greatest variety of spicules is found in this sponge. We will briefly describe the several kinds:

- (1) The most common kind is the rather large, straight or slightly curved, smooth, gradually tapering sharp-pointed spicules amphioxi similar to those found in so many of the *Spongillidae*. These vary a good deal in length and thickness and often the axial canal can be seen in them.

Average ones 360  $\mu$  long by 25  $\mu$  thick

Slender ones 374  $\times$  25  $\mu$

Thicker ones 340 - 410  $\times$  24 - 32  $\mu$  thick.

- (2) There are also some few spicules similar to the above except that they are of almost a uniform thickness throughout their entire length and have their ends rounded instead of sharp amphistrongyli. They measure 320  $\times$  28  $\mu$ .
- (3) Some, the styles, have one end rounded while the other end is gradually sharpened. These are generally shorter than those numbered 1 and 2 above.
- (4) Others, the tylostyles, are similar to number 3 except that the rounded end becomes enlarged until it is bulb-like.



- (5) Frequently spheres or „beads” of silica of varying size are found scattered through the sponge. These may be smooth or they may have spines of varying numbers and sizes projecting from them in one or more planes. The author of the species discusses the origin and formation of these spheres in a most interesting manner in his work mentioned above. He stresses the fact that all of these unusual types of spicules found in the skeleton cannot be considered as specific characters because some of the other sponges, notably *E. fluviatilis*, often present similar variations in spicule form. He further holds all, except those numbered 1, to be abnormal forms resulting from some traceable mechanical or pathological cause.

#### Gemmules.

No gemmules were found in these sponges.

#### Flesh Spicules.

There are no flesh spicules, though the skeleton contains many normal and also a large number of abnormal types of spicules.

#### Type.

The type of this species is in the Berlin Zoological Museum and we have, through the kindness of Dr. ARNDT, a minute bit of the sponge from that Museum in our collection.

#### Distribution.

This sponge is known up to the present time only from the one original locality, Lake Posso, Celebes, and only from the specimens originally collected there.

#### Remarks.

We refer the reader to the very full description of this species given by WELTNER in his Spongillidenstudien IV.

The following comparison with other sponges is a free translation from the original description: "*E. fluviatilis* has spicules somewhat similar in form and size to those of *Pachydictyum* but all the amphioxi are smaller, the firm skeleton has also a different structure, it is like a network and the main fibers are thinner than those of *Pachydictyum*. TOPSENT called attention to the long, thick fibers in the upper part of *Potamolepis barroisi* which could be clearly seen by the unaided eye, but even these never equal in thickness the main fibers of *Pachydictyum globosum*. *P. barroisi*, according to TOPSENT, has its main fibers made up of from 6 to 7 spicules, but *Pachydictyum* has as many as from 7 to 12 spicules in its main fibers. In addition to this difference the structure of the stratum of these two sponges is also quite different, in *Potamolepis* it is narrow and like a network, the skeleton needles are all pointed abruptly and do not attain a size equal to those *Pachydictyum*."

A number of the smaller spicules of *Trochospongilla leidyi* are similar in form to those of *Pachydictyum*; the skeleton of the former also has its main fibers of considerable thickness.



## NOTES ON SOME REPTILES FROM THE DUTCH-EAST-INDIES

by

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(Buitenzorg)

This paper is based on the collection of Reptiles present in the Buitenzorg Museum. I had the opportunity to make a revision of this collection and as I found, that it contained some new and rare specimens I thought it worth while to give a list of the species of interest.

### Lacertilia

*Hemidactylus Garnoti* D.B.

Two new localities:

Timor, collection Mrs. WALSH, II 1929, one specimen.

Wai-Sano, West Flores, collected by myself on VI 1929, one specimen.

*Draco fimbriatus* KUHL.

New localities:

Pekalongan, without date or collector, one specimen.

North Borneo, legit Mohari 1912, one specimen.

***Japalura nasuta*** nov. spec.

Type locality, North Borneo, Leg. Mohari 1912, 6 specimens.

Snout as long as the diameter of the orbit. Canthus rostralis sharp in the male, rounded in the female. Supraciliary edge somewhat erect, prominent, a little serrated, composed of flat compressed scales. This row of scales is followed by a much shorter row on the canthus rostralis, which is separated from the compressed supranasal by 2 (3) very small scales in the male, by 5 (4) in the female. Upper head scales keeled irregular, those on the occiput and on the supraocular region largest. Two or three enlarged scales on the temporal region. No tubercle behind the supraciliary edge. Gular pouch and gular fold indistinct. A laterally compressed vertical appendage on the tip of the snout, which is narrowest at the base and covered with imbricate keeled scales. The anterior edge is serrated and slightly curved backward. The length of the appendage is 3 mm. Nostril in the nasal, the laterally compressed supranasal is pointing outward. Tympanum hidden. 9 (8) keeled upperlabials, 8 (9) keeled lowerlabials; 4 or 5 enlarged chinshields on each side. A small nuchal crest in the male, composed of 7 small erect scales, with 2 rows of still smaller erect scales at the base. The dorsal crest on the anterior part of the back is composed of



enlarged keeled scales, on the posterior part it is not more than a dorsal ridge. Nuchal and dorsal crests are indistinctly separated by a notch. In the female there is only a continuous nuchal and dorsal ridge. In both sexes the dorsal ridge continues on the tail over a distance, which does not exceed the length of the tibia.

Body slightly compressed, covered above and on the sides with small keeled scales, intermixed with larger ones, all having their points obliquely directed upward and backward. Ventral scales larger than the dorsals and laterals, strongly keeled. Limbs covered with unequal strongly keeled scales. Digits strong, bicarinate below. Caudal scales equal all strongly keeled, as large as ventrals. Tail compressed, slender, two times the length of head and body.

Limbs strong, the adpressed hindlimb reaches the tip of the snout or beyond. Tibia much longer than the skull. Fourth finger a little larger than third, much larger than fifth, fifth toe as long as third.

Colour in spirit, probably much faded, uniform light brown. A dark transverse band on the upper surface of the head, bordered on both sides by lighter ones. Tail with dark and light annuli.

*Table of measurements*

no.	length of head & body mm	length of tail mm	distance axilla-groin mm	length of forelimb mm	length of hindlimb mm	sexe
1 (type)	53	110	25	29	55	♂
2	54	—	25	34	59	♂
3	52	102	25	31	52	♀
4	38	82	18	22	40	♀
5	52	—	23	32	54	♀
6	45	—	20	26	50	♀

*Lygosoma leucostictum* MÜLLER.

The description of this species is based on one specimen of uncertain locality, Java with? It is therefore of interest that I found in the collections of the Zoological Museum a second specimen of this species from Pengalengan, Malabar, West-Java, collected by OUWENS IV 1906. This specimen answers exceedingly well to the description given by MÜLLER, perhaps the earopening is somewhat larger. The number of supraciliaries is 8 on the left side, 7 on the right side. Length of head and body 142 mm, tail 85 mm.

*Lygosoma fuscum* (D.B.)

New locality: Soë, South Timor, collection MRS. WALSH I 1929, one specimen.

*Lygosoma uniliniatum* DE ROOY.

Fak Fak, New Guinea, 1 specimen.

Earopening with 3 l, 4 r. obtusely pointed lobules anteriorly. First labial fused with the nasal. Frontonasal 2/3 as broad as long. 6 supraciliaries. 33



smooth scales round the middle of the body. Praeanals not enlarged. 12 l., 14 r. lamellae under the fourth toe.

Five dark longitudinal lines, continued on the tail.

The black vertebral line is as in the type continued on the tail, but it is in this specimen accompanied by two black lines on each side.

These black lines are in the type only indicated between the shoulders (DE ROOY, Rept. Indo-Austr. Arch. I 1915 p. 208, fig. 80). The coloration as regards the black lines is apparently very variable in this species as in the specimen from Idenburg river (DE JONG, Nova Guinea XV Zool livr. 3 1927 p. 315) only part of the dorsal black line is visible.

### Ophidia

#### **Typhlops soensis** nov. spec.

Type locality: Soë, South Timor, altitude 880 m, legit MRS. WALSH II 1929, 9 specimens.

Snout rounded projecting. Nostrils lateral. Rostral about half the width of the head, extending to the level of the eyes, inferior portion about one time and one third as long as broad. Nasal incompletely divided, the cleft proceeding from the second labial to the rounded canthus rostralis, nearly reaching the rostral. Praeocular present, as broad as the ocular, in contact with the second and third labials. Eye distinct its anterior margin under the posterior margin of the praeocular. Praefrontal, supraocular and parietal enlarged. Praefrontal narrowly in contact with the rostral. 4 upper labials.

Body with 22 scales round the middle, its diameter 41-49 times in the total length. Tail one time to one time and three fifth as long as broad, ending in a small sharply pointed spine.

Olive above, the scales edged with light, lips white. Lower surface whitish, each scale with a brownish spot. A light transverse streak across the anal. Tail below with larger dark spots.

*Table of measurements*

No.	total length mm	diameter mm	length of tail mm	diameter of tail mm
type 1	230	5,—	5	4,—
2	283	5,5	5	4,5
3	227	5,—	8	5,—
4	290	6,—	6	5,—
5	275	6,—	6	5,—
6	245	5,—	5	4,5
7	150	3,5	3,5	2,5
8	225	4,5	6	3,5
9	122	3,—	3	2,—



This species is narrowly related to *T. polygrammicus* SCHLEGEL, the main difference being that the nasal cleft proceeds from the second instead from the first labial. Perhaps, when more material will be available, it will be regarded as a subspecies, but as in all my specimens the nasal cleft proceeds from the second labial, and as there are other slight differences with *T. polygrammicus* it is for the present better to regard it as a distinct species.

*Typhlops polygrammicus* SCHLEGEL.

One specimen collected by myself at Wai-Sano, West Flores, XI 1929.

*Python molurus* (L.)

Collected at Garoet, West Java, one specimen.

*Nordoa boa* (SCHLEGEL).

Manado, Selebes, one specimen.

This species is known from the eastern part of New-Guinea and Bismark Archipelago, so that the locality Selebes seems rather strange. As a matter of fact I am not quite sure, that the specimen mentioned above was really collected there. On the other hand however it is a rare species with burrowing habits, so that we can not be sure of the impossibility of its occurrence on Selebes either.

Of this specimen the rostral is just visible from above, the right internasal is fused with the praefrontal. One large praecocular is in contact with the frontal. There are 2 postoculars. 10 upperlabials, of which the 4th, 5th and 6th enter the eye. 4 of the posterior lower labials are pitted. Scales in 36 rows, ventrals 253, subcaudals 48 (11/11, 3, 16/16, 2, 16/16). Length of head and body 510 mm., tail 95 mm.

*Elapoides fuscus* BOIE.

One specimen from North Borneo collected by MOHARI 1912.

*Amblycephalus laevis* BOIE.

One specimen from Idjen plateau, East Java. Leg. H. LUCHT VII 1921.

*Laticauda colubrina* (SCHN.)

Of this species I could examine 12 specimens from different localities as shown in the table below.

The identification of some of the specimens (4, 6, 8, 9, 12) however afforded some difficulty. According to MALCOLM SMITH (Mon. Sea-Snakes 1926, p. 3) using the key to the species of *Laticauda*, the difference between *Laticauda colubrina* and *L. semifasciata* is that in the latter species the rostral is horizontally divided and the upper lip is brown. In the above mentioned specimens however the rostral is horizontally divided, but the upper lip is yellow.

In *L. semifasciata* the number of ventrals is 195-205, in *L. colubrina* 213-245. All my doubtful specimens had at least 226 ventrals, so that I identified them all as *L. colubrina*. On page 7 MALCOLM SMITH (op. cit.) gives some



no.	locality	collector	sexe	number of scale-rows neck/body	ventrals sub-caud- als	tempor- als	number of black bands	rostral divided	intersub lingual
1	Dobo	—	♀	25/27	249/34	1 + 2	39 + 4	—	+
2	Dobo	—	♂	21/23	223/43	1 + 2	42 + 5	—	—
3	Dobo	—	♂	21/23	230/44	1 + 2	40 + 5	—	—
4	Kaap Toedja N. Nw. Guinea	K. Gjellerup 4-2-'12	♂	21/23	223/44	1 + 2	36 + 6	Div.	—
5	Banda	—	♂	21/23	222/44	1 + 2	43 + 6	—	+
6	Ambon Toeal	Vorster 1907	♀	23/25	228/35	1 + 2	44 + 4	Div.	+
7	Kei-Islands	H. C. Siebers III 1922	♀	23/25	235/35	1 + 2	38 + 3	—	+
8	Batavia	—	♂	23/23	214/45	1 + 2	47 + 5	Div.	+
9	Koepang	—	♂	23/25	226/38	1 + 3	36 + 4	Div.	+
10	South coast Bali	—	♂	23/23	234/43	1 + 2	37 + 4	—	+
11	South coast Bali	—	♂	23/25	236/46	1 + 2	42 + 5	—	—
12	unknown	J. Ch. F. Sohn IX, 1917	♀	23/25	226/38	1 + 2	32 + 4	Div.	+

variations which he found in different specimens. To this list we may now add: rostral sometimes horizontally divided, in many specimens from the Malay Archipelago. In one of my specimens, no. 1, the number of scales is 25 round the neck, 27 round the middle of the body. In the same specimen the number of ventrals is 249. One other scale variety is found in no. 12, where the female has 38 subcaudals. In five specimens I found a variation not mentioned by MALCOLM SMITH, cf. a small azygous shield between the anterior and the posterior sublinguals (in the table as inter-sublingual).

One other specimen not mentioned here, which I identified as *L. semifasciata* because of the low number of ventrals had a white upper lip. Examining all these variations the only difference which remains between *L. colubrina* and *L. semifasciata* is in the number of ventrals. Perhaps an other collection will prove that this difference is not valid either and then the two species will be united, although it is quite possible that it are really different species.







# SPOLIA MENTAWIENSIA. LONGICORNIA

von

BERNHARD SCHWARZER

(Aschaffenburg).

[This paper deals with some of the beetles collected by myself, Mr. N. SMEDLEY and Dr. H. H. KARNY during our visit in September, October and November, 1924, to the islands of Siberut, Sipora and North and South Pagi of the Mentawi Group off the west coast of Sumatra, an archipelago of which the insect fauna was very little known (vide Bull. Raffles Mus. No. 1, 1928, p.2, P.Z.S., 1928, p.53 and map). During our journey to and from these deep-water islands a few days were spent at Padang, on the coast of Sumatra; and a few hours on Pulo Tello, one of the Batu Islands, which stand in the shallow water bordering the Sumatran coast, and notes on the insects obtained in these two places have been included here. This is the twenty-ninth report to be published on the collections obtained.

C. BODEN KLOSS,

Director of Museums, Straits Settlements  
and Federated Malay States.]

Diese Ausbeute gibt aufs Neue den Beweis, dass die entlang der Westküste von Sumatra gelegenen Inseln: Simalur, Nias, Batu, Mentawai und Engano viele endemische Arten besitzen. (Die Faunen von Nias und Engano wurden 1907 durch GAHAN; „Fauna Simalurensis“ 1924 durch AURIVILLIUS bearbeitet). Die vorliegende Ausbeute enthält 11 neue Arten; ausser diesen konnten einige wahrscheinlich auch neue Arten der Gattungen *Pterolophia* und *Sybra* noch nicht benannt werden. Ob von den neuen Arten einige auch auf dem Festlande von Sumatra, oder den obengenannten Inseln vorkommen, ist nach dem heutigen Stande unserer Kenntnis noch nicht zu sagen, wohl aber leicht möglich. Andererseits konnten einige von Nias und Engano beschriebene Arten festgestellt werden. *Glenea scripta* GAHAN ist jetzt von allen Inseln bekannt.

Die Typen der neuen Arten sind im British Museum.



## PRIONINAE.

- 1). *Hystatus javanus* THOMS., 1 ♂, Pageh.

## CERAMBYCINAE.

- 2). *Aeolesthes induta* NEWM., 1 ♂, Pageh.  
 3). *Hoplocerambyx spinicornis* NEWM., 2 ♂♂, 1 ♀, Siberut, 1 ♀ Sipora.  
 4). *Dialeges pauper* PASC., 1 ♀, Sipora.  
 5). *Ceresium flavipes* F., 1 ♂, Siberut.  
 6). *Dejanira quadripunctata* THOMS., 1 ♀, Sipora.  
 7). *Chlorophorus annularis* F., 1 ♀, Mentawai.  
 8). *Euryphagus lundii* F., 1 ♀, Padang, West Sumatra.

## LAMIINAE.

**Parabybe** nov. gen.

Mit *Bybe* PASCOE völlig übereinstimmend, nur hat das Halsschild an der Seite ein kräftiges Dörnchen. Da PASCOE die Gattung *Bybe* wegen der völlig abgerundeten Halsschildseite zur Trennung von *Parmena* LATR. aufstellt, muss für die vorliegende Art, die sonst dem gleichen Habitus wie *Bybe parmenoides* PASC. hat, eine neue Gattung errichtet werden.

9). ***Parabybe subfoveolata*** n. sp. Hellbraun bis schwarz, sehr fein aschgrau pubesziert. Kein Epistom. Augen klein, mässig ausgerandet, grob fazettiert, unterer Lappen länger als breit, Wangen länger als der untere Augenlappn; Stirn und Scheitel dicht und grob punktiert. Fühler beim ♂ etwas kürzer als der Körper, die Basis der Glieder heller, 3. u. 4. Glied gleich lang, das 5. etwa halb so lang wie das 4. Halsschild grob und sehr dicht punktiert, am Vorderrande ein wenig schmaler als an der Basis, seitlich schwach gerundet und in der Mitte ein kräftiges Dörnchen. Schildchen breiter als lang, hinten breit abgerundet. Flügeldecken an der Basis das Halsschild überragend, an der Spitze gemeinschaftlich schmal ausgerandet, in der Mitte am breitesten und höchsten; grösstenteils gereiht punktiert, in der Mitte fast grubig, bis zur Spitze sehr stark. Beine mässig stark, alle Tibien in der Mitte breit rötlich geringelt; Mitteltibien vor der Spitze tief ausgeschnitten, Klauen divergent.

Länge 4 bis 5½ mm.

Typus: Siberut, (C. B. K. and N. S. Sept. 1924).

Paratypus: Sipora, KARNY leg., im Senckenberg-Museum, Frankfurt a. M.

- 10). *Nephelotus conspersus* THOMS., 1 ♀, Siberut.  
 11). *Epepeotes fuscus* F., 30 Exempl.  
 12). *Epepeotes basalis* GAHAN, 1 ♂, Pageh; 1 ♀, Padang, West Sumatra.  
 13). *Pelargoderus semitigrinus* RITS. 1 ♀, Padang, West Sumatra; 1 ♀, Siberut.

Beim 2. Stück fehlen die beiden schwarzen Dorsalmakeln. Es ist nicht ausgeschlossen, dass diese Eigenschaft bei den Stücken von Mentawai konstant ist,



doch will ich keinen neuen Namen geben, ohne weiteres Material gesehen zu haben.

14). *Dihammus rusticator* F. 13 Exempl. Siberut, Sipora, P. Tello (Batu).

15). *Orsidis sobrius* PASC. 1 ♂, P. Tello (Batu), 1 ♂ Sipora. (C. B. K. and N. S.).

16). *Orsidis dispar* PASC. 6 Exempl. Siberut, Sipora.

17). ***Orsidis pleuralis*** n. sp. Rotbraun, Oberseite fein aschgrau pubesziert, Unterseite fein seidenartig behaart. Die Epipleuren auffallend stark weissgrau behaart. Stirn und Scheitel mit feiner Mittellinie, erstere zerstreut punktiert, letzterer glatt. Augen sehr gross, grösser als bei den verwandten Arten, gerundet; Wangen sehr kurz. Fühler beim ♂ doppelt so lang wie der Körper, rotbraun, vom 3. Gliede ab mit aschgrauem Basalteil. Halsschild auf der Scheibe zerstreut punktiert. Schildchen gerundet, dicht behaart. Flügeldecken nach hinten verlöschend, grösstenteils gereiht punktiert. Epipleuren vorn breit und vertical, nach hinten zu verschwindend. Beine ziemlich schlank.

Länge 13 mm.

Typus: Sipora (C. B. K. and N. S., Okt. 1924).

Paratypus: Pageh, KARNY leg. im Senckenberg-Museum, Frankfurt-Main.

18). *Neopharsalia vagans* KANNEGIETER, 2 Exemplare Siberut.

19). *Euthyastus binotatus* PASC., 1 ♂ Siberut.

20). *Batocera rubus* L. Rasse: ***siporensis*** n. — *B. rubus* L. ist über Indien, Südchina, Formosa, die Philippinen, Sumatra, Java und Borneo verbreitet und bildet naturgemäss viele Rassen, denen auch meistens Namen gegeben wurden. Stücke aus Java sind auf den ersten Blick erkennbar an der nur ihnen eigenen grauen Farbe; die Stücke aus Sumatra und Nias sind rötlich oder rotbraun gefärbt. Die vorliegenden Stücke aus Sipora bilden in der Färbung einen Uebergang zwischen diesen beiden Formen. Die Stücke sind habituell besonders kräftig, die Halsschildmakeln sind nierenförmig und weit getrennt, jede Flügeldecke hat nur 3 Makeln in ziemlich gleicher Entfernung, die erste und dritte ist sehr klein, die mittlere ist gross, difform und erscheint nach hinten verlängert. Keine der beschriebenen Rassen von *rubus* hat grössere Aehnlichkeit mit *siporensis*, diese hat mehr Aehnlichkeit mit *celebiana* THOMS. *B. thomsoni* JAVET hat zwar auch nur 3 Makeln, aber die mittlere ist klein und rund. Ferner hat *thomsoni* ganz anders gebaute Fühler und beim ♂ am ersten Glied der Vordertarsen einen Dorn, ähnlich wie einige andere *Batocera*-Arten (*nebulosus* BATES). Infolgedessen kann *thomsoni* nicht als Rasse oder Aberration von *rubus* L. gelten, wie es im „Catalogus“ pars 73, p. 126 angegeben ist.

Typus: Sipora (C. B. K. and N. S., Okt. 1924).

Paratypus: Pageh (leg. KARNY) im Senckenberg-Museum.

21). *Apriona irma* KRIESCHE, 1 ♂, 1 ♀, Siberut (C. B. K. and N. S.), 1 ♂, Sipora.

22). *Apriona durgo* KRIESCHE, 1 ♂, Siberut.

23). *Gnoma confusa* THOMS., 1 ♀, Siberut, 1 ♂, Sipora.

24). *Anancylus basalis* GEH., 1 Exempl. Siberut.



25). **Ancanthocacia punctipennis** n. sp. Relativ kurz und breit. Schwarz, mit grauen und gelblichen Haarflecken scheckig bedeckt. Stirn breit behaart, mit winzigen Graneln undicht besetzt. Augenlappen weit getrennt, durch feine Leisten miteinander verbunden; unterer Lappen rund. Wangen fast doppelt so lang wie der untere Augenlappen. Fühler kräftig, kürzer als der Körper, 3. u. 4. Glied an der Basis breit hell geringelt und an den Spitzen mit starkem Dorn bewaffnet. Halsschild breiter als lang mit geraden Seiten, mit flachen Punktgrübchen und einigen kleinen Körnchen zerstreut bedeckt; ohne Querrunzeln. Flügeldecken fast gradseitig, an der Spitze gemeinschaftlich abgerundet, bis zur Spitze ziemlich stark und ziemlich dicht punktiert. Apikalteil der Schienen und Tarsen braun.

Länge 7 mm.

Typus: (?) Nord Pageh (C. B. K. and N. S., Okt. 1924).

26). **Cacia integricornis** n. sp. Schwarzbraun, mit grauen Flecken bedeckt. Kopf einfarbig grau behaart, hinter jedem Auge ein brauner Fleck und zwischen der Fühlerhöckern ein schmaler brauner Querstreifen. Augen sehr tief ausgerandet, fein faszettiert, unterer Lappen gerundet, etwas breiter als hoch, Wangen  $1\frac{1}{2}$  mal so lang als jener. Fühler relativ dünn, beträchtlich länger als der Körper, auf der Unterseite bewimpert, das 3. 4. u. 5. Glied an der Basis schmal grau geringelt, sonst ohne jede Verdickung oder dichtere Behaarung. Halsschild breiter als lang, an den Seiten zerstreut grob punktiert, grau behaart, ein breiter Mittelstreifen und daneben jederseits ein gekrümmter, schmälerer, unterbrochener Streifen, braun. Flügeldecken bis zur Spitze undicht punktiert mit grauen Flecken bedeckt, die jederseits 2 grössere braune Flecken freilassen, der erste hinter der Basis, der zweite hinter der Mitte. Beim ♀ ist die Behaarung der Flügeldecken etwas spärlicher, sodass die braunen Flecken stärker hervortreten, die Flecken in der Mitte bilden eine unvollständige Binde. Unterseite einfarbig grau pubesziert.

Länge 6 mm.

Typus: 1 ♂, Siberut (C. B. K. and N. S. Sept. 1924).

Paratypus: 1 ♀, Siberut (C. B. K. and N. S. Sept. 1924), im Senckenberg-Museum in Frankfurt-Main.

27. **Cacia subfasciata** n. sp. Rotbraun, Kopf einfarbig grau behaart; hinter jedem Auge ein breiter Streifen schwarz. Fühler länger als der Körper, 4. Glied mit starkem schwarzem Haarbusch, an der Basis schmal weissgrau geringelt, das 5. Glied mit Ausnahme der Spitze weissgrau. Halsschild oben mit zwei schwarzbraunen Längsstreifen, an den Seiten punktiert. Flügeldecken mit zerstreuten Punktgrübchen besetzt, diese sind in der Mitte am stärksten und verlöschen vor der Spitze, rötlichgelb behaart, eine undeutliche braune Binde hinter der Basis und drei Flecken auf jedem Seitenrande treten deutlich hervor; der erste kleinere hinter der Schulter, der zweite, grösste hinter der Mitte erreicht beinahe die Naht, der dritte kleinste vor der Spitze. Unterseite einfarbig grau behaart. Schienen in der Mitte breit weissgrau behaart.

Länge 9 mm.



Typus: 1 ♀, Sipora (C. B. K. and N. S. Okt. 1924).

28). *Grammoechus polygrammus* THOMS., 1 ♂, 1 ♀, Sipora, 2 ♂♂, Siberut.

29). *Olenecamptus bilobus* F., 1 ♂, Siberut.

30). *Xenolea tomentosa* PASC., 7 Exempl. Siberut, Sipora, P. Tello (Batu).

31). *Nyctimene varicornis* F., Siberut, Sipora, P. Tello (Batu).

32). ***Micromulciber sumatrensis*** n. sp. Oberseite dicht gelblich, Unterseite, Beine und Fühler grau behaart; Kopf, Halsschild, die Seiten der Flügeldecken, insbesondere aber die Unterseite, die Beine und die ersten Fühlerglieder mit braunen Fleckchen gezeichnet. Kopf zwischen den Fühlerhöckern flach und breit ausgebuchtet. Augen grob granuliert, ausgerandet (nicht geteilt). Erstes Fühlerglied kurz und dick, birnförmig. Halsschild breiter als lang, an der Basis jederseits ausgebuchtet, vorne gerade abgeschnitten, seitlich in der Mitte mit einem Höcker. Schildchen breiter als lang, hinten breit gerundet, dicht behaart. Flügeldecken nach hinten allmählich verschmälert, vor der Spitze etwas ausgeschweift, jede Spitze schräg nach innen abgestutzt, jederseits mit einem grossen braunen Fleck, der auf dem Seitenrande aufsitzt, die Naht nicht erreicht und hinten durch eine meist unterbrochene, schiefe, weissliche Binde begrenzt wird. Prosternalfortsatz abgerundet; Mesosternalfortsatz mit einem länglichen Höcker, vertikal. Der Einschnitt der Mitteltibien ist nicht sehr deutlich.

Länge 12 mm.

Typus: Siberut (H. H. KARNY, Sept. 1924).

Paratypen: 1 ♂, Pageh, 1 ♂, Padang, W. Sumatra (C. B. K. and N. S. Nov. 1924).

Die Zeichnung der Flügeldecken erinnert an jene von *Trachelophora curvicollis* PERROUD, mit welcher Art sie auch durch die Bildung der Augen und anderer Merkmale verwandt ist. Die Gattungen der *Homonoeini* sind nicht homogen.

33). *Trachelophora curvicollis* PERROUD, 5 Exempl. Pageh, Siberut, Sipora.

34). *Pterolophia albivenosa* PASC., Pageh, Siberut, Sipora. 17 Exempl.

35). *Pterolophia melanura* PASC., Padang, (West Sumatra); Siberut, Sipora, Batu.

36). *Pterolophia propinqua* PASC., 5. Exempl., Siberut, Sipora.

37). *Pterolophia illiaca* PASC., P. Tello (Batu).

38). *Pterolophia*

39). *Pterolophia*

40). *Pterolophia*

41). *Pterolophia* 4 verschiedene Arten, zu deren Bestimmung das Studium der Typen im British Museum erforderlich ist.

42). *Egesina rigida* PASC., 1 ♂, Sipora.

43). *Apomecyna alboguttata* MEGERLE, Siberut.

44). *Ropica alboplagiata* var. *binotata* GAH., Siberut, Sipora.

45). *Ropica alboplagiata* var. *obscura* GAH., Siberut.

Die beiden vorgenannten Varietäten beschrieb GAHAN in: Ann. de Museo Civ. Genova, 1907, p. 87, sie sind im Cat. Col. JUNK nicht aufgeführt.



- 46). *Sybra solida* GAH., Sipora.  
 47). *Sybra binotata*, GAH., P. Tello (Batu).  
 48). *Sybra* } 2 verschiedene Arten (wie oben).  
 49). *Sybra* }  
 50). *Pothyne strigata* GAH., 1 ♀, Sipora.  
 51). *Cleptometopus filifer* PASC., 4 Exempl. Siberut, Sipora.  
 52). *Cleptometopus enganensis* GAH., 9 Exempl. Siberut, Sipora.  
 53). *Glenea elegans* OL., 1 ♀, P. Tello (Batu).  
 54). *Glenea numifera* THOMS., 2 Exempl. Siberut, Sipora.  
 55). *Glenea dejeani* GAH., 4 Exempl. Siberut, Sipora.  
 56). *Glenea scripta* GAH., 6 Exempl. Siberut, Sipora.  
 57). *Glenea algebraica* THOMS., 1 ♀, Sipora.

58). ***Glenea dorsalis*** n. sp. Schwarz, Flügeldecken (unter der Behaarung) rotbraun, Beine rotgelb, Fühler schwarz, Behaarung auf der Oberseite gelblich, auf der Unterseite grau. Stirn und Scheitel zerstreut punktiert, die Augenränder dichter, sonst dünn behaart. Scheitel mit drei ziemlich breiten Längsstreifen, zerstreut punktiert. Schildchen etwas breiter als lang, hinten in sehr schwachem Bogen abgestutzt, dicht behaart. Flügeldecken allmählich zur Spitze verengt, jede Spitze schief eingebuchtet abgestutzt, der Aussenwinkel spitzig ausgezogen. Oberseite zum Teil gereiht, zur Spitze verlöschend punktiert. Der Suturalstreifen bedeckt im ersten Drittel die ganze Oberseite, verschmälert sich dann bis zum grossen Spitzenfleck; eine schmale Schulterbinde tritt nicht sehr deutlich hervor und bildet hinter der Mitte, in dem unbehaarten Raume, eine Makel. Die auf der Unterseite bewimperten Fühler überragen beim ♂ die Flügeldecken mit vier Gliedern.

Länge  $7\frac{1}{2}$  mm.

Typus: 1 ♂, Siberut (C. B. K. and N. S. Sept. 1924).

59). ***Glenea cincticornis*** n. sp. Schwarz, Flügeldecken braun, die Basis heller, Abdomen rotbraun, Beine rötlich, Schienen dunkler, Fühler schwarz, Apikalteil der 8. bis Basalteil des 11. Gliedes gelblich. Kopf zerstreut fein punktiert, weisslich behaart mit 2 Scheitelstreifen. Halsschild subquadratisch, fein zerstreut punktiert, mit einem Dorsal- und je einem Seitenstreifen; der Raum zwischen dem Dorsal- und dem Seitenstreifen ist fast doppelt so breit wie der Raum zwischen dem Seitenstreifen und der Behaarung der Unterseite; Schildchen gross, hinten abgerundet. Flügeldecken hinter den etwas vortretenden Schultern schwach verengt, jede Decke an der Spite nach innen schräg abgestutzt, Aussenwinkel scharf zugespitzt, oberer Seitenkiel verlöscht weit vor der Spitze. Oberfläche zur Spitze verlöschend, grösstenteils gereiht punktiert. Jede Flügeldecke hat einen Nahtstreifen, der hinter dem Schildchen beginnt und meist in den Spitzenfleck endet und einem Schulterstreifen, der den Spitzenfleck nicht erreicht, sowie hinter der Basis einen kurzen schrägen Dorsalstreifen und in der Mitte einen Punkt oder kurzen Strich, grauweiss behaart. Unterseite dünn behaart, erste Abdominalsegmente an den Seiten mit je einem nackten Fleck. Hintertarsen kurz, 1. Glied etwa so lang wie die beiden folgenden.



Länge 6 bis 7 mm.

Typus: Siberut (C. B. K. and N. S., Sept. 1924).

Paratypus: Sipora (C. B. K. and N. S., Okt. 1924) im Senckenberg-Museum, Frankfurt-Main, 9 Exempl., Pageh, Siberut, Sipora.

Unzählige Arten der Gattung *Glenea* haben in der Anlage der Flügeldeckenzeichnung dieselbe Tendenz wie diese neue Art.

60). ***Glenea longitarsis*** n. sp. Schwarz, Oberseite mit blauen oder blaugrünen Zeichnungen, Unterseite dünn graublau behaart, Beine rotgelb, Schienen und Tarsen der zwei vordern Beinpaare schwärzlich, bläulich pubesziert, Hinterschienen braun, Hintertarsen lang, gelblich, mit dünner bläulicher Pubeszenz; erstes Glied so lang wie die drei folgenden zusammen. Kopf fein zerstreut punktiert, zwei genäherte Scheitelstreifen nach hinten verkürzt. Halsschild an der Basis und am Vorderrande gesäumt — an Letzteren nach der Mitte zu stark verbreitert — und einem Dorsalstreifen. Schildchen gerundet, dicht bläulich behaart. Flügeldecken an der Spitze schräg abgestutzt, die Aussenecke kurz bedornt, unregelmässig, zur Spitze verlöschend punktiert; ein schmaler grauer Suturalstreif, eine undeutliche (Typus) nicht immer vorhandene Schulterbinde mit drei Makeln, eine kurze Dorsalbinde hinter der Basis und ein Fleck vor der Spitze, ein kleiner Fleck in der Mitte ist meist mit dem grösseren Fleck in der Humeralbinde vereinigt.

Länge  $7\frac{1}{2}$  bis 10 mm.

Typus: Siberut (C. B. K. and N. S., Sept. 1924).

Paratypus: Sipora (C. B. K. and N. S., Okt. 1924) im Senckenberg-Museum, Frankfurt-Main.

7 Exempl. Siberut, Sipora.

61). ***Nupserha rufopicea*** n. sp. Halsschild, Schildchen, Basalviertel der Flügeldecken, Unterseite — mit Ausnahme des letzten Abdominalsegmentes — die Beine — mit Ausnahme der angeschwärzten Tibien und Tarsen — rot, alle andern Körperteile schwarz. Der ganze Körper ist sehr fein silberig pubesziert und mit zerstreuten aufstehenden Börstchen besetzt. Kopf gewölbt, Stirn mässig dicht, Scheitel dichter punktiert. Halsschild hinter dem Basalteil etwas eingeschnürt, in der Mitte schwach bauchig erweitert, unpunktiert. Flügeldecken hinter den Schultern allmählich verschmälert, jede Decke schief ausgebuchtet, der Nahtdorn kurz, der Aussendorn länger, Oberseite gereiht punktiert, im letzten Viertel unpunktiert, nach 2 Punktreihen eine Rippe.

Länge 14 mm.

Typus: 1 ♀, P. Tello (Batu) (C. B. K. and N. S., Nov. 1924).

Von relativ robuster Körperform. Ein zu dieser Art gehöriges Exemplar durch Herrn JACOBSON mitgeteilt aus Anai Kloof, West Sumatra, hat schlankere Körperform, die schwarze Farbe der Flügeldecken ist in der Mitte ausgebuchtet, d. h. zum obern Seitenkiel etwas vorgezogen; rot gegen schwarz etwa  $\frac{1}{3}$  zu  $\frac{2}{3}$ .

62). ***Ossonis mentawensis*** n. sp. Schwarz, mit seidenartiger grauer Behaarung, Flügeldecken bräunlich, an den Seiten dunkler mit drei verwaschenen

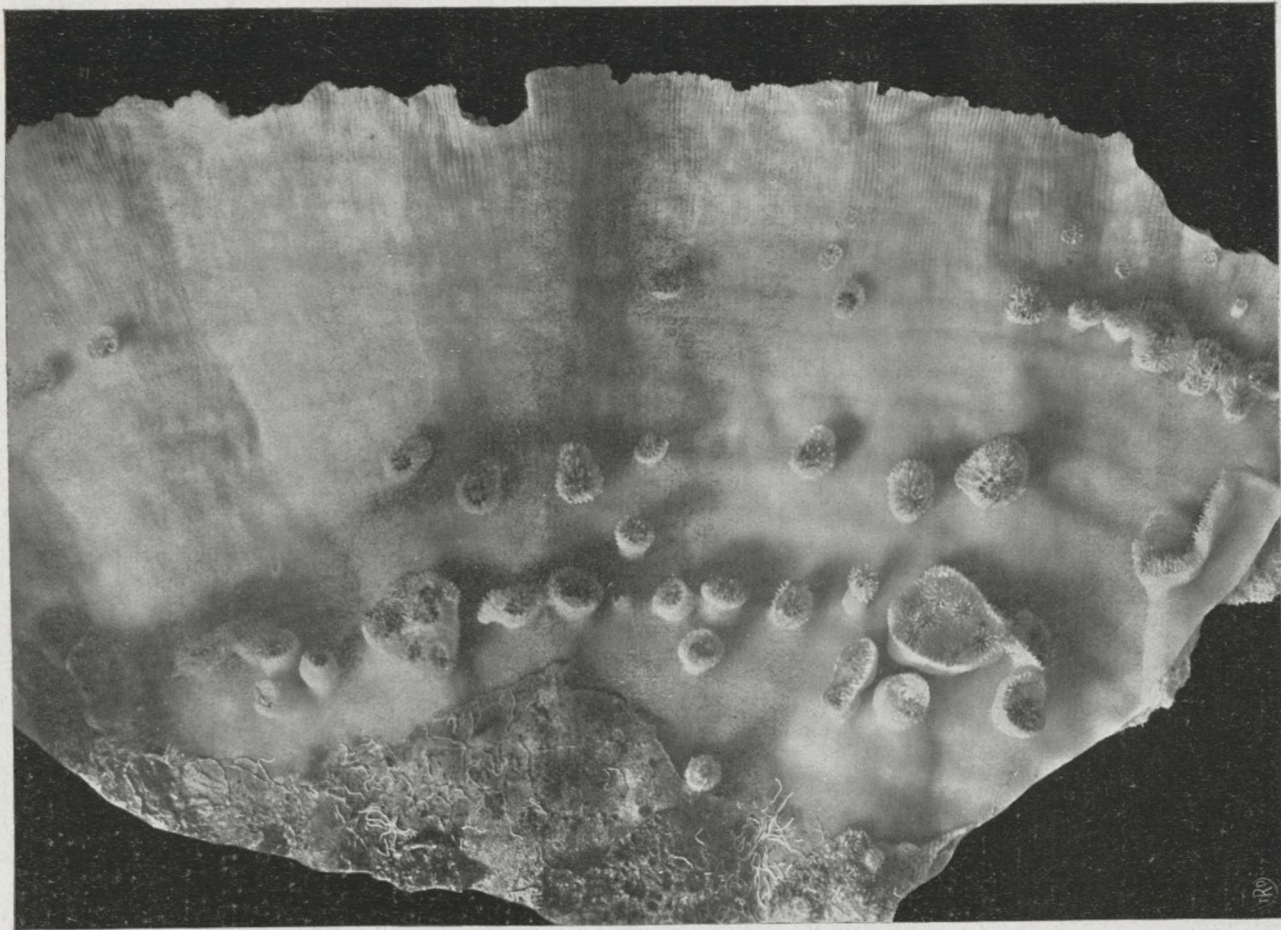


gelben Binden; die erste vom Schildchen jederseits nach hinten gerichtet, die zweite hinter der Mitte, gerade, an der Naht etwas verbreitert, den Seitenrand nicht erreichend, die dritte auf der Spitze, diese ist breit und gerade abgesetzt. Kopf und Scheitel gleichmässig behaart und zerstreut punktiert. Augen fein faszettiert, gross, unterer Lappen oval und fast doppelt so lang wie die Wangen. Fühler dunkel, vom 6. mit der Basis des 10. Gliedes gelb. Halsschild punktiert mit drei verwaschenen Längsbinden; eine schmale in der Mitte und je eine breitere an der Seite. Flügeldecken an der Basis gröber, an der Spitze feiner, zerstreut punktiert. Beine gelblich, Hinterschinkel vor der Spitze gebräunt. Hintertarsen lang, erstes Glied fast doppelt so lang wie die beiden folgenden.

Länge 7 mm.

Typus: 1 ♂, Pageh (H. H. KARNY, Oktober 1924).





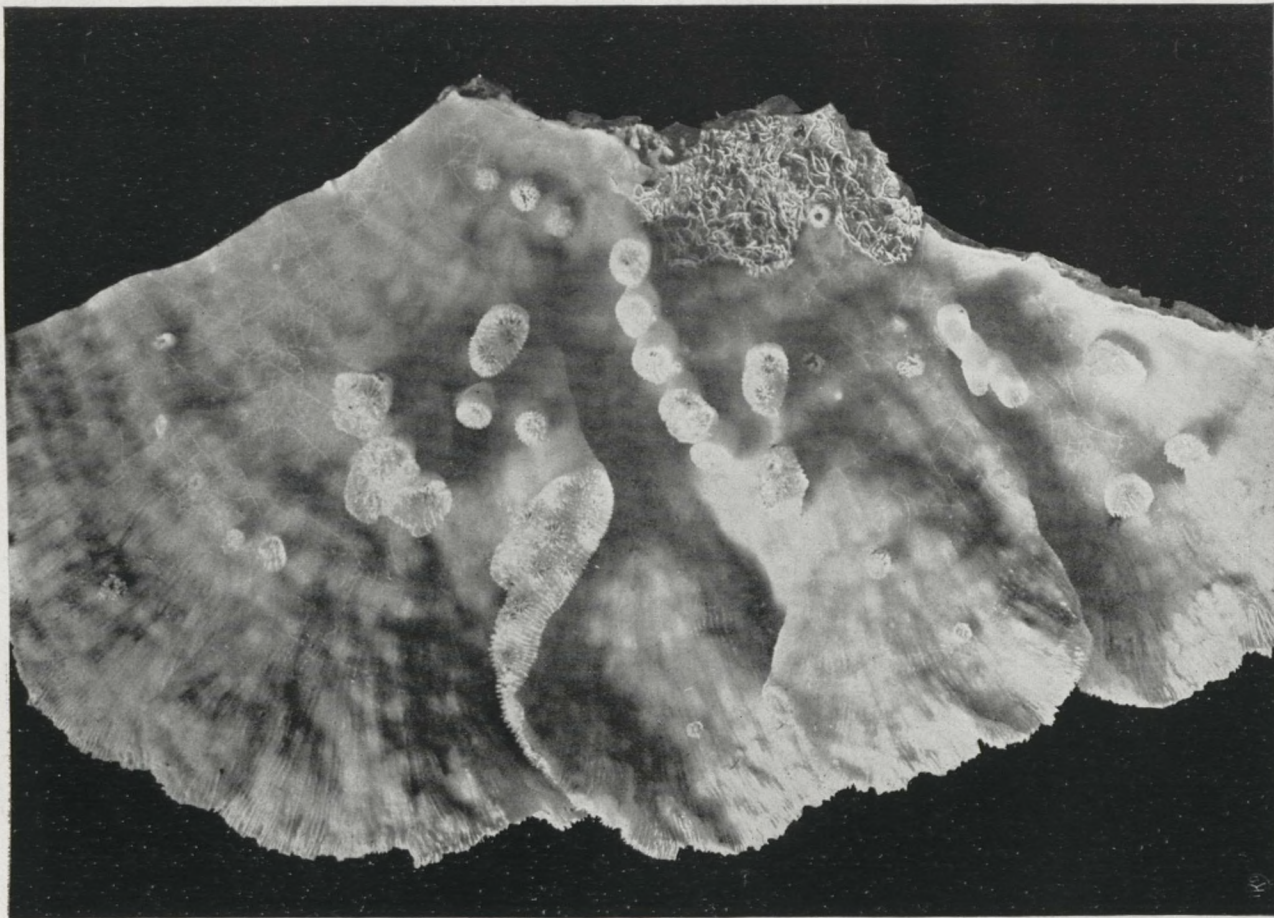
BOSCHMA phot.

Fig. 1. *Echinopora lamellosa*: lower surface of a colony from the island Hoorn, Bay of Batavia, 2 July, 1929, with stalked buds in concentric rows. Natural size.









BOSCHMA phot.

Fig. 2. *Echinopora lamellosa*: lower surface of a colony from the island Hoorn, Bay of Batavia, 2 July, 1929, with stalked buds in lines radiating from the central of the colony. Natural size.









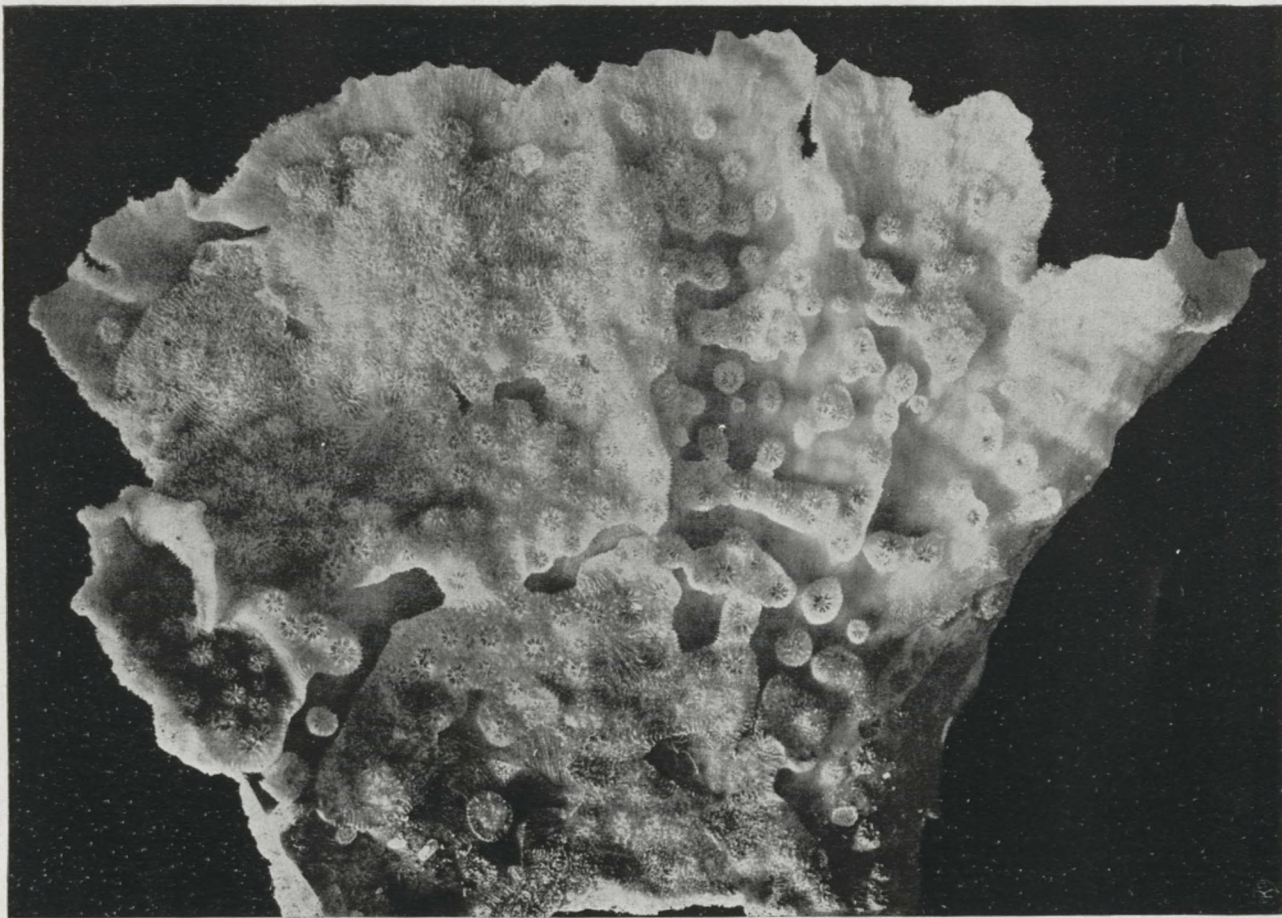
BOSCHMA phot.

Fig. 3. *Echinopora lamellosa*: lower surface of a colony from the island Onrust, Bay of Batavia, 24 January, 1929, covered with numerous stalked buds. Natural size.









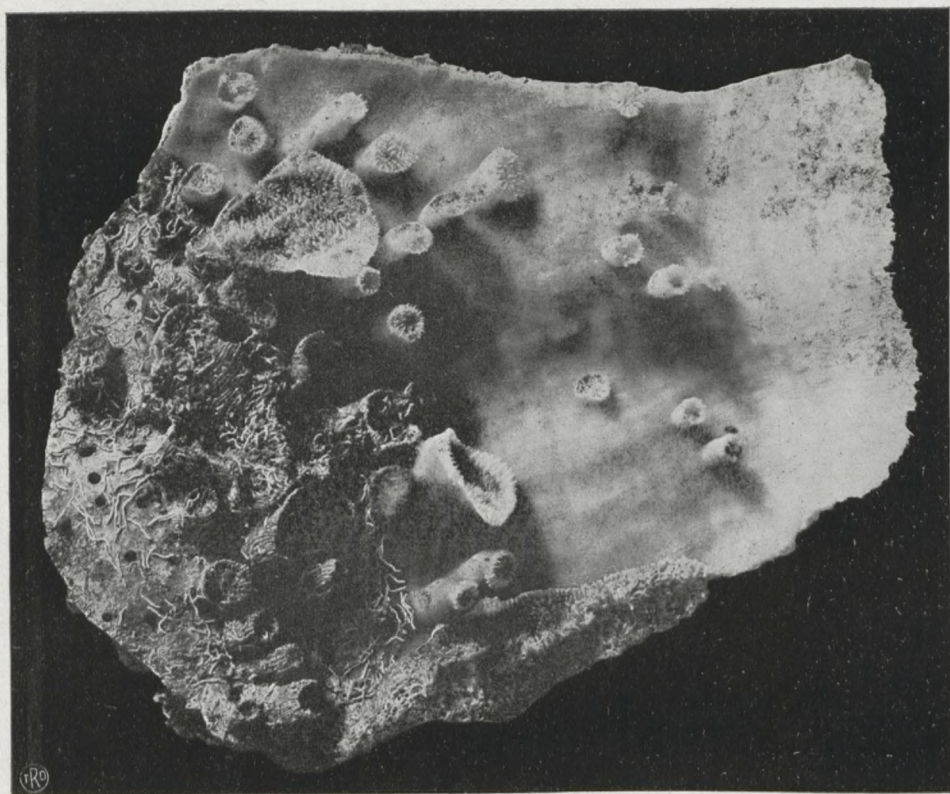
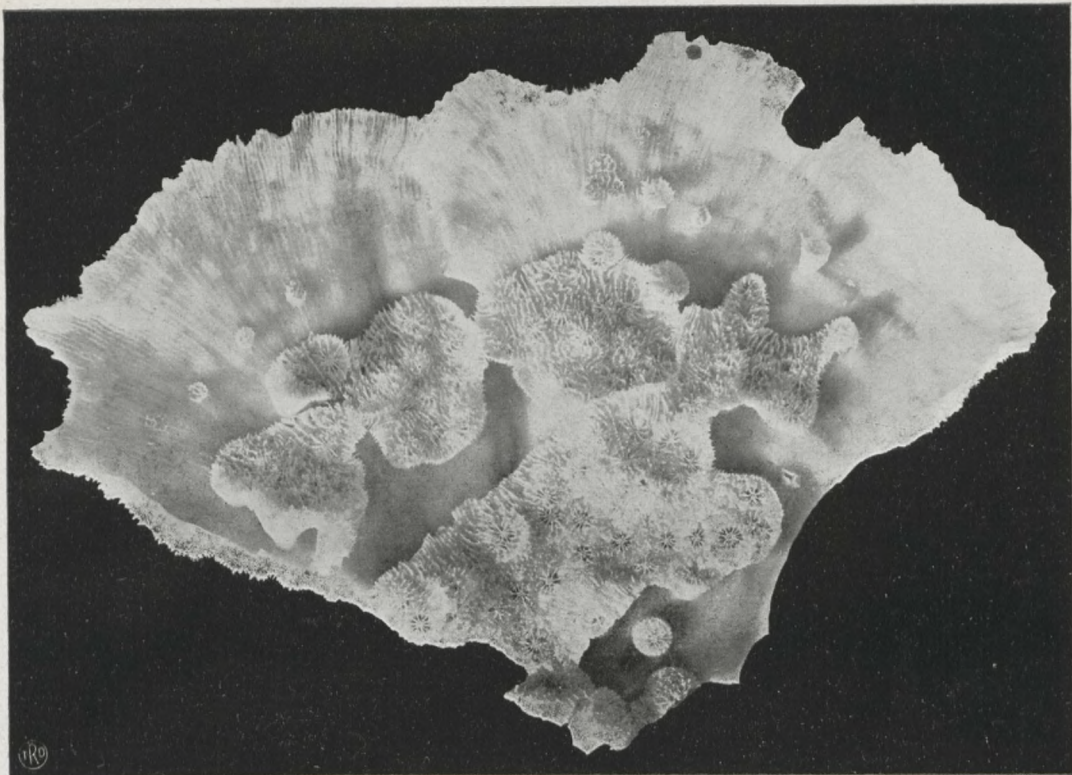
BOSCHMA phot.

Fig. 4. *Echinopora lamellosa*: lower surface of a colony from the island Edam, Bay of Batavia, 19 June, 1929, covered with an extensive number of stalked buds, which are unifying coherent plates. Natural size.









BOSCHMA phot.

Fig. 5 - 6. *Echinopora lamellosa*: lower surface of colonies from the island Hoorn, Bay of Batavia, 2 July, 1929. Fig. 5. Stalked buds part of which have fused. Fig. 6 Stalked buds of great length. Natural size.







## THE OCCURRENCE OF STALKED BUDS IN THE CORAL *ECHINOPORA LAMELLOSA* (ESPER)

by

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and

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In a previous paper one of us (BOSCHMA, 1928) described a manner of budding in *Echinopora lamellosa* which had not been recorded before. Unlike the usual way of vegetative propagation this kind of budding results in the formation of stalked little corallites at regions of the underside of colonies which are partly open to light. As the buds hitherto had been found only on the reef of a small island in Sunda Strait, one was inclined to think that this kind of budding was an extremely rare phenomenon.

The other of us, however, in studying the reefs of the Thousand Islands (especially those of the Bay of Batavia), found that these colonies of *Echinopora* with stalked buds are not at all rare, so that the collection of the Laboratorium voor het Onderzoek der Zee at Batavia now contains a great many specimens showing this phenomenon. The few specimens described in the paper cited above gave an insufficient idea of the factors determining the development of these buds. From the material present in the Laboratorium voor het Onderzoek der Zee some more particulars on this manner of budding can be obtained, giving us a better insight into the question.

*Echinopora lamellosa* is a common species of coral on the reefs of Batavia Bay. It occurs chiefly on the north side of the islands, where the breakers are heaviest, together with colonies of the facies *platyphylla* of *Millepora alcornis*. These two species indeed are characteristic of this surfbeaten environment. Like *Millepora*, *Echinopora* occurs abundantly in exposed places, not only in sheltered localities of the reef, as stated by UMBGROVE (1928). Those colonies which live in sheltered places differ from more exposed ones by their more foliate appearance, the latter tending to develop into pillar-like domes, the sides of which consist of thick plates, one above the other, usually bending



downwards at the free extremity. This manner of growth results in a strong massive colony, the parts of which offer great resistance to the destructive action of the surf.

Of the factors governing the development of the stalked buds in *Echinopora* light doubtless is the principal one, as the parts of the colonies, where these buds are formed, always are more or less exposed to light. From the fact that vertical plates of *Echinopora* develop corallites on both sides from the very outset we have to conclude that the failing of corallites on the underside of normal horizontally growing plates is due to want of light. Where these plates (after some time) change their growth into a more upward direction, favourable circumstances for the development of corallites arise, which now, however, generally differ from normal ones by possessing longer stalks.

The stalked buds develop only at a certain distance from the free margin of the colony. It appears that the corallum must have a certain thickness before buds are formed. As the margin grows out and the corallum increases in thickness new buds may be formed on its lower surface. This phenomenon is distinctly visible in fig. 1. In fig. 3 the buds seem to have arisen in the immediate vicinity of the margin, but in this colony the thin marginal parts have broken after it had been collected. — In the course of further growth of the colony the buds of the older set increase in size, so that often several groups of these buds, each group on the average comprising buds of a certain size, may be found in the same colony, the largest buds being found in its oldest part. In fig. 1 three of such groups are to be seen, each consisting of a row of buds parallel to the margin of the colony.

Concentric rows of buds, as those represented in fig. 1, occur in many colonies of *Echinopora lamellosa*. A more detailed study of this phenomenon shows that the formation of concentric rows of buds must have something to do with concentric thickening of the corallum, as the rows of buds coincide with the concentric layers of greater thickness of the latter. One may ask again why these concentric rows of greater thickness and the interjacent thinner parts develop. As a possible explanation we venture to regard as such the influence of the monsoons with their strong winds from alternating directions. Favourable circumstances during one monsoon period perhaps result in the formation of a greater quantity of lime at the margin of the corallum, forming a layer of greater thickness as might also be produced by strong stationary growth (cf. the annual rings of trees). As soon as rows of greater thickness have developed conditions may be favourable for the formation of buds, as remarked before.

Often colonies of *Echinopora* are found which show a tendency of widening their plate-like growth. When this tendency is hindered by lack of space it often results in the formation of folds and ridges, as in the corallum represented in fig. 2. When buds do occur then the latter may especially have arisen in rows radiating from the centre of the corallum. The several individuals of a certain row then may have approximately the same size, which indicates that probably they have originated at the same time.



In *Fungia* buds are found to develop especially in parts of the corallum in which intensive growth occurs resultant on damages of the corallum (BOSCHMA, 1923). This may hold in an equivalent way for some cases of budding in *Echinopora*. When, e.g., radiating rows of buds grow on folds of the corallum, we doubtless are dealing with the development of buds in places predisposed for this phenomenon. As already stated, however, the normal development of corallites on both sides of vertical plates shows that light is the chief factor here, accordingly there is little reason to assume that budding as in *Fungia* is of much importance in *Echinopora*.

Concerning the further development of the stalked buds the available amount of light is the chief factor determining their shape. Buds which have arisen at a spot which during the further growth of the colony receives very little light (this may be caused by a more or less downward bending of the new margin of the colony) show a strong tendency to develop long stalks (fig. 6). The stalks grow out towards the margin of the colony in order that the polyps may receive as much light as possible. These buds, however, have little opportunity for their further development: often the amount of light in these more or less shut off places is too scanty for their remaining alive. In many cases one finds that a number of these buds, especially those which occupy the darkest region, have died, as, e.g. in the case of the corallum of fig. 6.

When, on the other hand, a sufficient quantity of light can penetrate to the surface of the corallum where the stalked buds have developed, the stalks of these young corallites remain short (fig. 3). Growth of the buds then proceeds in a lateral direction and soon two or more buds unite laterally, forming a small compound corallum. In the course of further development this process continues and soon a large part of the surface, which originally was devoid of polyps, is covered by corallites (fig. 5). Besides the original polyps (the buds) there develop a great number of new polyps in the ordinary way: they arise in the coenosarc between the existing polyps. Different stages of this gradually covering of the lower surface of a colony by a plate-like growth which has originated from isolated buds, are to be seen in fig. 4. The right part of this figure shows a number of isolated buds and a great quantity which have already united into rows and patches of corallites. The left part of the same corallum is almost completely covered by corallites; small open places between these indicate that originally this part of the colony was devoid of polyps.

The manner of budding described here brings about a quite different shape of the colony. By this process the appearance of the colony resembles that of the colonies of *Echinopora*, which grow out vertically. In these colonies, however, both sides of the vertical plate possess corallites at the very outset, whereas in the colonies described above the similarity of both surfaces has been acquired in a secondary manner. Nevertheless in both cases we are certainly dealing with the same phenomenon.



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## ON a BLACK VARIETY of *FELIS TEMMINCKI* from SUMATRA.

By

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(Buitenzorg Museum).

Last year the Museum at Buitenzorg came into possession of a black variety of *Felis temmincki* through the kind offices of the late Mr C. L. v. D. PLAS, Assistant-Resident of Pajakombo, Sumatra's West Coast. The animal was trapped by Mr F. RINNER, 17th January 1929, near Loeboek Koeok, at an elevation of 800 m.

A description of this almost entirely black specimen follows here.

*Colour*: Upperparts glossy black with brownish hue and a very few white hairs intermingled. Fur consisting of longer hairs, black with lighter bases, and dark greyish woolly hairs. Head black above; the long whiskers brownish; ear on the outside black; inside sparsely haired, blackish hairs around the margin, and a few white hairs with dark tips at the inner corner. Underparts brownish black, white hairs more numerous; breast and belly of a still lighter colour owing to the absence of the long black hairs. Of the typical markings of normal specimens nothing is to be seen excepted a narrow dark stripe on the cheeks between the mouth-angle and the ear, and very faintly indicated narrow black bands on the throat. The small spots on the breast can also be traced. Tail above same colour as the back; underneath dark greyish brown.

*Measurements* (those of a normal example between brackets): —

Total length: 1080 mm (1162); head and body, 660 mm (743); tail, 420 mm (419).

*Skull*: basilar length, 106.8 (118.2); zygomatic breadth, 85.7 (91); least postorbital breadth, 34.1 (32.7); median length of nasals, 22.8 (29.8); length upper molar series, 28.0 (29.8); length lower molar series, 27.8 (30.6).

The skull has the same shape as that of a red-coloured individual but is somewhat smaller; the true molar is already developed but not yet fully extruded; all canines, except the right upper one, are broken off.

A black or dark variety of *Felis temmincki* (*moomensis* HODGS.) from Nepal has twice been described and named: once by HORSFIELD in 1855 and once by GRAY in 1863.

HORSFIELD's description runs as follows:

"*Felis Murmensis*, HODGS. Proc. Zool. Soc. 1832, p. 10, *varietas nigra*. Mr. HODGSON has recently discovered a very beautiful variety, of a saturated brown or black colour, of which the collection contains several specimens. In size and external character it agrees exactly with the brown-red or bay species,



first described in the 'Proceedings of the Zoological Society'. The lateral marks on the cheeks, forehead and thighs are the same, and also a slight whitish discoloration on the tip of the tail. It is a very beautiful variety". (Extract from Ann. Mag. of Nat. Hist. Vol. XVI, 1855, p. 105) <sup>1)</sup>

The second name was made valid by GRAY in his 2nd edition of the "Catalogue of specimens and drawings presented by B. H. HODGSON to the "British Museum" (1863). The description (p. 4) is as follows:

"*Felis nigrescens* HODGSON n. sp. Hab. Darjiling Jan. 1849.

Very like *F. murmensis* and may possibly be a black variety of it". <sup>2)</sup>

From the descriptions it is not quite clear whether these two varieties are identical, the *nigra* of HORSFIELD having the characteristic marks of the typical *temmincki* still quite distinguishable, but both varieties were based on specimens collected by HODGSON. It seems probable that GRAY, when validating HODGSON's name, was unaware that HORSFIELD had already described the black variety.

The finding of this black variety of *temmincki* in Sumatra is of interest in connection with the controversy about the presence of the common panther (*Felis pardus*) in Sumatra. Several authors maintain the occurrence of the black panther in Sumatra, but there seems to be no material from Sumatra in any collection neither of normally coloured nor of black panthers. The only more or less positive record is by SCHNEIDER (Zool. Jahrb. Syst. Bd. 23, 1905, p. 102), who saw a black specimen in captivity at Tandjung Laut (Sumatra's East Coast); the beast escaped, however.

An interesting note on this question was written by JACOBSON (Journ. F.M.S. Mus. X 1921, p. 238) who concludes his article with the following words:

"My opinion, that the normally coloured *Felis pardus* does not live in Sumatra is still unshaken, and I am very much inclined to believe that the black animals shot or seen in this country are nothing else than melanistic examples of *Felis nebulosa*".

Now the above-mentioned record of an entirely black variety of *temmincki* may help to solve the problem. This melanistic specimen looks very much like a black panther and may easily be mistaken for it, at least when closer examination is excluded. Only the size is much smaller and therefore it may be that also black individuals of *Felis nebulosa* occur which are looked upon as black panthers.

<sup>1)</sup> I owe this extract to the kindness of the Director of the Indian Museum, Calcutta; the said volume of the Annals being neither in our library nor in Singapore.

<sup>2)</sup> I have to thank Mr. C. BODEN KLOSS of Singapore for this note, as we have not got the above-mentioned publication.



## CONTRIBUTIONS TO THE DRAGONFLY-FAUNA OF THE DUTCH EAST INDIES

### II

by

M. A. LIEFTINCK,

(Buitenzorg Museum).

With 25 text-figures.

The following notes form the second part of a series of papers which I intend to publish from time to time on malayan *Odonata*. As in my first contribution on the same subject <sup>1)</sup>, most species come from Java, whilst attempts have been made firstly to give careful descriptions of new species and secondly to look over again those published by several authors at a time when it was not yet custom to supply descriptions with indispensable figures of structural features. When comparative material of related species was available, I have endeavoured to insert them either in diagnostic tables or dealt with them more in detail. A large amount of splendid *Odonata* was sent to me again by Mr. F. C. DRESCHER (Bandoeng), to whom I am especially indebted for the utmost exactitude and care with which his material was labelled and preserved. Up till now no less than 90 species were collected by DRESCHER in Java <sup>2)</sup>, only very few of this material having already sufficiently been dealt with in previous papers or in the present one. As to the illustrations, so far as structural parts are concerned these are original drawing-prism figures. With regard to the vein-terminology, I have once again retained the revised COMSTOCK-NEEDHAM notation, used by CALVERT, RIS and others.

The following species have been discussed or described as new in the text:—

*Rhinocypha mariae*, sp. n. — S. Sumatra.

*Protosticta simplicinervis* SELYS — Celebes.

*Caconeura corvina*, sp. n. — Java.

*Caconeura delicatula*, sp. n. — Java.

*Risoneura selysi* FOERSTER — Soemba, Flores.

*Risoneura fruhstorferi* KRÜGER — Sumatra, Java.

*Agriocnemis minima* SELYS — Java.

*Agriocnemis nana* LAIDLAW — Malacca.

*Teinobasis helvola*, sp. n. — S. Celebes.

<sup>1)</sup> The first part entitled "Contributions ..... of the Sondaic Area" was published in *Tijdschrift voor Entomologie*, 72, 1929.

<sup>2)</sup> About 66 per cent of the total number of species known from the island.



*Hemicordulia tenera*, sp. n. — Java.

*Procordulia artemis*, sp. n. — Java.

*Procordulia sumbawana* FOERSTER — Java.

*Gynacantha bayadera* SELYS-RIS — Java.

*Gynacantha basiguttata* SELYS — Java.

*Platycantha dirupta* KARSCH — Kei.

Fam. CALOPTERYGIDAE.

Subfam. EPALLAGINAE.

**Rhinocypha mariae** sp.n.

2 ♂ ad., Sumatra mer., Lake (Danau) Ranau distr., East of Soerabaja, 600 m., 28.X.1929, Mrs. and Dr. VAN STEENIS leg.

Allied to *R. angusta* SELYS, but slightly larger and comparatively more robust.

♂ ad. (Holotype). — Head velvety black, almost unmarked. Labium bluish green, tips of median and lateral lobes black. Ventral base of mandibles green; their tips as well as the maxillae dark chestnut-brown. Face otherwise black, very shining. A small linear reddish spot on the outer side of each posterior ocellus, a scarcely visible round postocular spot on each side and lastly a small, transverse median yellow spot at posterior margin of occiput. This black, but interiorly with an arch-like fascia of bluish pruinosity against the prothorax. Sides of prothorax with two yellowish spots, otherwise black.

Thorax velvety black, lam. mesostigm. shining yellow. Colour-pattern very similar to *R. angusta*. Mesothoracic triangle short, black, its posterior half clear yellow, this spot triangular in shape. A minute yellow spot on each side before the antealar ridge, which itself is entirely black. Dorsum of mesepisternum with a large, rather rounded olive-green mark, exactly similar in size and shape to that present in *angusta*, its outer margin lying close to the humeral suture. Dorsal half of humeral suture bordered with clear yellow exteriorly, separated from the large mesepisternal band. A broad, oblique, very ragged unbroken fascia enclosing anteriorly an irregular area, in the middle of which the stigma is situated; posteriorly it ceases before  $\frac{4}{5}$  of length of metepisternum, finely separated from a thick stripe filling up the dorsal  $\frac{1}{3}$  part of metepimerum, olive-green in colour with orangish tint. Ventral side of thorax largely black; only two rounded spots in the middle of *poststernum* and an oblong transverse band at sutures slightly pruinose.

Legs black, interior sides of first pair of femora with basal and apical yellow spot, of middle and hind femora bright sulfur yellow; inner side of middle and hind tibiae pure white.

Wings of equal width, both pairs evenly saffronated, especially at the bases. Apices of both pairs of wings brown, with slight metallic reflex. Inner border of the dark colour very concave, irregular, in general following the bend of the



wing itself. In front wing extending about 6 cells proximad of pterostigma in subcostal space, running obliquely to the posterior margin of the wing to a level of middle of pterostigma; then gradually tapering away on the hinder border of wing and extending inward to about the same level of about 5 cells proximad of pterostigma. Costal space, from about 6 cells distad of nodus, diffusely brown. In hind wings the distal portion is darker brown, in radial space extending outwards from about 6 cells distad of nodus to a level just in the middle of the wing, 7-8 cells proximad of pterostigma, then suddenly turning back and tapering away to the posterior margin, extending inwards to about the same level as the starting-point. Inner border of this fascia but slightly irregular and rather sharply defined. Subcostal space almost hyaline, costal space brownish as in the fore wings. Nodal index  $\frac{32.14.15.29}{30.15.17.27}$ ; cross-veins in quadrangle  $\frac{4.4}{4.5}$ . Pterostigma black, covering 7 cells.

Abdomen almost entirely black, pattern reduced; slightly bluish metallic, shining, terminal segments with coppery reflex. Segm. 1 with a bluish mark aside, triangular in shape; 2 with a minute termino-dorsal point of the same colour and 3-5 with very narrow lateral transverse lines at extreme base. Appendages black.

Length: abd. + app. 21, hw. 26, pt. 2.4 mm.

The paratype differs from the type specimen chiefly in the extension of the brown colour in the apical part of the wings. In both pairs the brown is not so extensive and its interior border is much less concave. In front wing the apical band begins in radial space at a level below proximal side of pterostigma, filling up the tips, whilst the costal space is also brownish from a level about midway between nodus and pterostigma; in hind wing the colour begins in radial space at about 14 cells proximad of nodus, then arcuately concave to the middle of the wing and lastly straight on to the wing border, the margin slightly brown further inwards. Nodal index  $\frac{32.19.18.33}{33.20.16.29}$ ; cross-veins in quadrangle  $\frac{4.4}{4.4}$ .

Length: abd. + app. 22, hw. 27, pt. 2.4 mm.

Female unknown.

Closely allied to *R. angusta* SELYS but rapidly distinguished from it by its wing-pattern, lacking vitreous spots at all. The arrangement of light markings on thorax and abdomen is very similar in both species; a slight difference of perhaps minor importance strikes one in the colour, the light thoracic markings in adult *angusta* being always of a beautiful pinkish or lilaish tint, in both males of *mariae* it is soft olive-green. A further difference may be found in the markings on poststernum; in *angusta* this area is black decorated with two pairs of large subtriangular or squarish spots, whilst *mariae* only has two small rounded, yellow spots in the centre of it.

The specimens were taken along a mountain stream in the forest; at a distance of but few miles *R. angusta* was met with in large numbers including the females, and in two other places in the neighbourhood this last named species was accompanied by a few individuals of the splendid *R. selysi* KRÜGER.



I have much pleasure in dedicating this remarkable species to Mrs. MARIA J. VAN STEENIS, a keen collector and botanist who found many valuable dragonflies during her stay in South Sumatra.

Fam. AGRIONIDAE.

Subfam. PLATYSTICTINAE.

**Protosticta simplicinervis** SELYS 1885.

*Protosticta simplicinervis* SELYS ♂ (*C. R. Soc. ent. Belg.*, 29, 1885, p. CXLV). — Hab.: Minahassa, N. Celebes.

*Protosticta simplicinervis* SELYS ♂♀ (*Revis. Sinopsis Agrionines*, 1886, pp. 157 -158). — Hab.: Minahassa and Bonthain (S. Celebes).

*Protosticta annulata* FRASER ♂ (*Treubia*, VIII, livr. 3 - 4, 1926, p. 492). — Hab.: Menado, N. Celebes, leg. MOHARI.

I have been able to examine FRASER's type specimen of *P. annulata* in the Buitenzorg Museum, a juvenile male with its terminal abdominal segments lost. Though this was already the case at the time of its description I am convinced that this male represents the same species as SELYS's *simplicinervis*; it fits the original description of the male from N. Celebes in a perfect way.

Subfam. PROTONEURINAE.

**Caconeura corvina** sp.n. (figs. 1 - 4).

122 ♂, 22 ♀ (partly juv., or taken in cop.), Java mer., res. Banjoemas, Djerboeklegi, north of rail-road Maos-Bandjar, 10-100 m., 17-22.X., 13-18.XI, 12-20.XII.1928; 7-12.I, 14.IV, 7.VII, 11-12.VIII, 18-20.IX, 21.X.1929, all F. C. DRESCHER leg.

2 ♂ ad., Java occ., Buitenzorg, 250 m., Botan. Garden, 27.XI.1929 and several males, idem, 9-23.III and VI-VII.1930, M. A. LIEFTINCK leg.

Holo- and allotype, Djerboeklegi, 7.I.1929.

♂ ad. — Labium black, whitish at base. Labrum shining black; head otherwise entirely velvety black. Eyes chestnut-brown. Prothorax black. Synthorax very dark velvet-black, with slight coppery reflex, especially on the dorsum and along the humeral suture. Mesepimerum and metepisternum in adult specimens entirely black, but usually with a longitudinal pale yellowish white fascia, covering the stigma. Metinfraepisternum and metepimerum with some pale markings, especially along the ventral border (fig. 1 a-b). Ventral side of thorax largely black, with ill-defined pale markings on the poststernum. Coxae and legs black, exterior sides of all tibiae with a narrow line, pale yellowish in colour. The lower lateral half of the synthorax and the ventral surface slightly bluish pruinose.



Wings narrow, hyaline, in adults somewhat smoky, pterostigma black. *Ac* lies midway between *Ax1* and *Ax2*; vestige of *Ab* always present, archlike, not

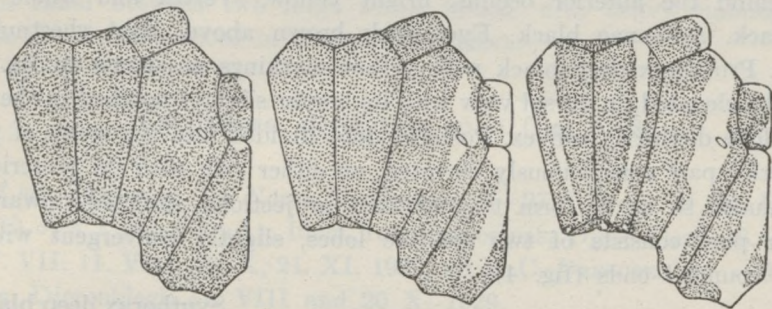


Fig. 1.—*Caconeura corvina*, sp. n. Java.  
Colour-pattern of synthorax; *a* adult male, *b* juv. male, *c* female.

meeting nerve descending from quadrilateral. *Cu1* reaching hinder margin 1-2 cells beyond subnodus in front wing, 2 or  $2\frac{1}{2}$  cells in hind wing. 13-14 post-nodals in front wing, 12 in hind wing. (fig. 2).

Abdomen long and excessively slender, almost completely black, very shining. Sides of segm. 1 and latero-ventral border of 2 narrowly whitish; min-

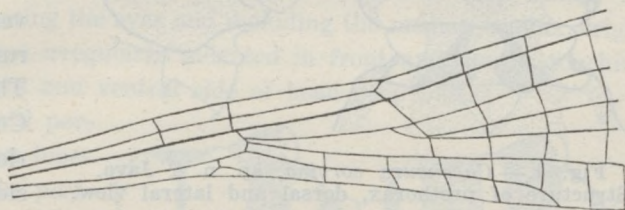


Fig. 2.—*Caconeura corvina*, sp. n. ♂ Java.  
Basal portion of hind wing.

ute transverse white spots at the base of segm. 3-7 on the dorsum and very inconspicuous brownish shades at the sides of 3-6, close to the posterior border of each segment. Remaining segments entirely black. Anal appendages largely black, tips of superiors yellowish; inferior appendages black, with interior portion yellowish and with dark brown tips (fig. 3).

Length: abd. + app. 29-31.5, hw. 18.5-19.5 mm.

♀ ad. (Allotype). — Labium yellowish white. Base of mandibles and labrum yellow, the latter with a minute brown spot in the centre, at base; anteclypeus very narrow, with two brownish spots. Postclypeus yellow, with three well-defined small brownish points. Face otherwise bright yellow. A broad transverse band, running from eye to eye, at base of antennae, with its

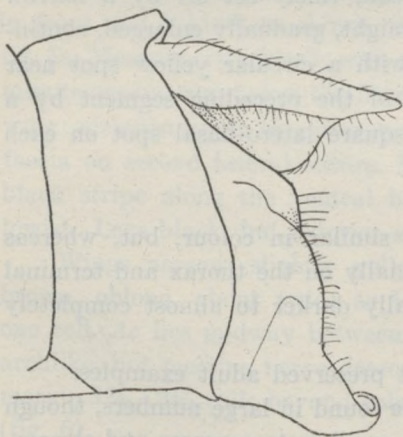


Fig. 3.—*Caconeura corvina*, sp. n.  
♂ Java.  
Anal apps., left side view.



anterior border just meeting base of the frons, deep black. A somewhat narrower transverse fascia, connecting the eyes, running from base of antennae to a level behind the anterior ocellus, bright yellow. Vertex and whole occiput deep black. Antennae black. Eyes dark brown above, light chestnut-brown beneath. Prothorax deep black with yellow markings as shown on fig. 4. Anterior lobe elevated, in dorsal view with its border slightly notched in the centre; median lobe distinctly convex. Posterior lobe divided into two pairs of processes; anterior part conspicuously elevated, on either side with its posterior margin produced so as to form two rounded projections, directed upwards; the posterior part consists of two ear-like lobes, slightly convergent with their broadly rounded ends (fig. 4).

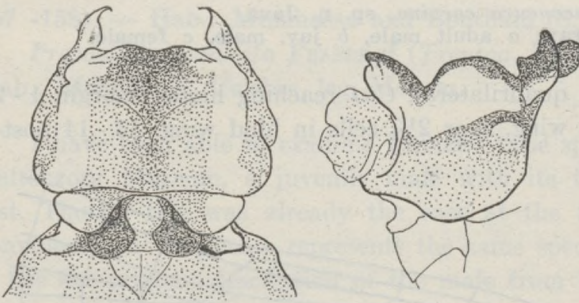


Fig. 4. — *Caconeura corvina*, sp. n. ♀ Java.  
Structure of prothorax, dorsal and lateral view.

Synthorax deep black with bright yellow markings. Complete, somewhat curved antehumeral lines, narrower above and two greenish yellow lateral bands. Latero-ventral border of metepimerum blackish brown (fig. 1c). Thorax ventrally dull yellow. Coxae and legs yellow, exterior sides of femora, interior sides of tibiae and all tarsi black.

Wings hyaline, neurulation as in the male, pterostigma dark brown, slightly larger than in male.

Abdomen largely black; minute paired transverse white spots at base of segm. 3-6. The black dorsal band on segm. 3-6 distinctly widened before the end of each. Sides with a reddish brown streak, finely set off by a narrow yellow line. Sides of segm. 7-9 black with a straight, gradually enlarged, continuous bright yellow line. Dorsum of segm. 9 with a circular yellow spot near the end, connected with the posterior border of the preceding segment by a fine longitudinal line. Segm. 10 yellow, with square latero-basal spot on each side. Appendages bright yellow. Valves black.

Length: 31, 18.5 mm.

Immature males and females are pretty similar in colour, but, whereas adult females show much light markings, especially on the thorax and terminal abdominal segments, the males become gradually darker to almost completely black.

As type specimens I have chosen the best preserved adult examples.

The males of this shade-loving species were found in large numbers, though very localized, under dense shrubs overhanging small water-sources and streamlets, near Djeroeklegi. Its highly cryptic coloration renders it very inconspicuous. Mr. DRESCHER told me that females are much less numerous but frequent-



ly could be taken during copulation. In the Botanical Garden at Buitenzorg I took two males hovering in a very peculiar face-to-face dance along a narrow junction canal between two large *Lotus* ponds, with heavy running water. Hitherto I did not succeed in dredging the larva.

***Caconeura delicatula* sp. n. (figs. 5-8).**

7 ♂ ad., Java mer., isl. Noesa Kambangan, 7-27. I, 3-11. II, 14. IV, 10. V. 1928. - 15 ♂, 3 ♀ (mostly ad.), Idem, res. Banjoemas, Djeroeklegi, 18. X. 1928; 12. I, 7. VII. 11. VIII, 20. X, 21. XI. 1929, all F. C. DRESCHER leg. - Holo- and allotype, Djeroeklegi, 11. VIII and 20 X. 1929.

♂ ad. - Labium yellowish brown. Labrum, clypeus and frons orange, labrum with obsolete brownish line at base and frons with two widely separated blackish pits in front. Face otherwise dull orange. Eyes brown. A transverse posterior band running from eye to eye and including the antennae deep black; an equally broad band, connecting the eyes and including the median ocellus, bright orange, this band somewhat irregularly indented in front and almost touching the posterior ocelli. Occiput and ventral side of head deep black.

Prothorax black; lateral portion of anterior and median lobes broadly orange, whilst the posterior lobe is entirely orange; median lobe with two small orange spots above. Synthorax very clear and pure orange above, the mid-dorsal line finely bordered with black, this colour slightly enlarged in front and behind, as shown on fig. 5a. Mesepimerum black, with a minute orange spot below the front

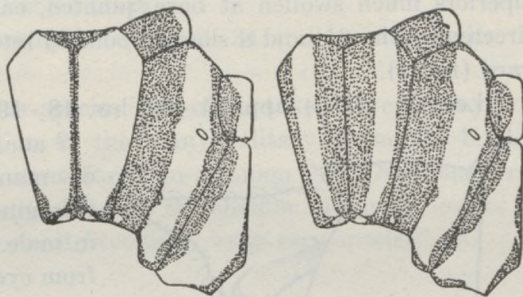


Fig. 5. — *Caconeura delicatula*, sp. n. Java. Colour-pattern of synthorax; a. adult male, b. adult female.

wing; metepisternum bright orange, separated from the metepimerum by a black fascia on second lateral suture. Metepimerum yellowish orange, an incomplete black stripe along the ventral border. Ventral side of thorax and coxae yellowish. Legs black, but exterior sides of all tibiae yellowish.

Wings narrow, slightly yellowish in very adult males, pterostigma dark brown, oblong, about twice as long as broad, covering somewhat more than one cell. *Ac* lies midway between *Ax1* and *Ax2*; vestige of *Ab* always present, archlike, not meeting nerve descending from quadrilateral. *Cu1* reaching hinder margin  $1\frac{1}{2}$  -  $2\frac{1}{2}$  cells beyond subnodus in front wing,  $2$  -  $3\frac{1}{2}$  cells in hind wing (fig. 6).

Abdomen long and excessively slender, almost completely black, very shining. Sides of segm. 1 and latero-ventral border of 2 narrowly orange. Dorsum



of 2 with a narrow orange median line, not touching posterior border of the segment. Minute paired, transverse, white spots at base of segm. 3-7 and a fine mid-dorsal longitudinal line on 3 present in several not fully adult males (in the adult type specimen these spots are only seen at base of segm. 3 and the mid-dorsal line on the same segment is hardly visible). Sides of segm. 3-6 with very diffuse brownish subterminal shades. Remaining segments black.

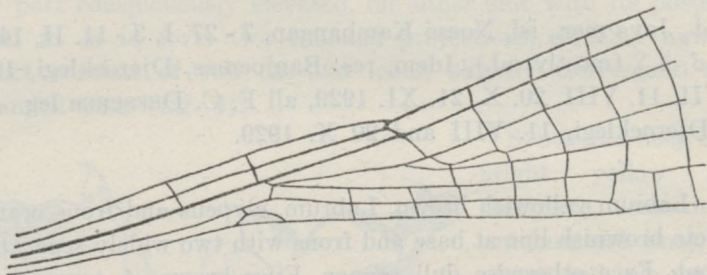


Fig. 6. — *Caconeura delicatula*, sp. n. ♂ Java.  
Basal portion of hind wing.

Superior appendages bright yellow above and interiorly, darkened beneath; inferior appendages yellow interiorly and laterally, with blackish tips. The superiors much swollen at base, pointed, each with a rounded external tooth, directed downward and a sharply pointed interior tooth, bent inward and downward (fig. 7).

Length: abd. + app. 31-32, hw. 18-19 mm.



Fig. 7. — *Caconeura delicatula*, sp. n.  
♂ Java.

Anal apps., left side view.

♀ ad. (Allotype). — Labium white. Base of mandibles, labrum and clypeus dull ferruginous, face light yellow; dark spots as in male. A broad transverse band, running from eye to eye, at base of antennae, slightly enlarged in the middle and touching the frons, deep black. A much narrower transverse fascia, connecting the eyes, running from base of antennae and including median ocellus to a level just before the posterior ocelli, yellow in the centre, bright orange aside. Vertex and occiput deep black. Eyes greyish brown, yellowish below. Antennae black.

Prothorax black, marked with pale orange, as shown on fig. 8. Anterior lobe elevated, straight in dorsal view and with two rounded lobes on each side. Median lobe distinctly convex. Posterior lobe with only one pair of processes; its side-lobes widely separated from each other and each furnished with a fairly long, raised, almost pointed process, bent forward (fig 8).



Synthorax deep black with sharp-cut orange and yellow markings. Complete straight antehumeral lines, widest at base, slightly narrower above; dark orange. Lateral bands yellowish white with distinct orange tint, especially that on the metepisternum. Latero-ventral border of metepimerum with two blackish streaks (fig. 5b). Ventral side yellow. Coxae and legs yellow, exterior sides of femora, knees, interior sides of tibiae and tarsi black.

Abdomen very long, largely black; minute, paired transverse spots at base of segm. 3-6 and a very fine longitudinal white mid-dorsal line on segm. 2 and base of 3. Sides of segm. 1-5 largely yellowish, with darkened longitudinal streaks; the black dorsal bands on 2-5 distinctly widened before the end of each. The light colour at the sides of segm. 6 and 7 reduced. Lateral part of 8-10



Fig. 8. — *Caconeura delicatula*, sp. n. ♀ Java. Structure of prothorax, dorsal and lateral view.

black with a straight, continuous yellow line and on the dorsum of the same segments a gradually enlarged line of the same colour, divided into two at the end of segm. 10. Appendages and valves black.

Length: < 34, 20 mm. (Size varies between 32-34 and 19-20 mm.).

This beautiful and conspicuous species was often taken in company with *corvina*, but, when paying attention to the many solitary examples, brought home from its favourite haunts, it seems far from common. Mr. DRESCHER wrote to me (dd. 4. II. 1929): „..... very shy; hides in the shadow of shrubs low to the water's surface along sources and small brooks. A very rare species”.

### **Risoneura selysi** FOERSTER 1896 (figs. 9-12).

*Caconeura Selysii* ♂ FOERSTER (*Ann. Soc. entom. Belg.*, 40, 1896, pp. 423-424).

— Hab.: Soemba.

*Caconeura selysi* ♂♀ RIS (*Abh. Senckenb. Naturf. Ges.*, 34, 1913, pp. 508-512).

— Hab.: Timor.

Material studied: 4 ♂, 2 ♀, N. E. Soemba, Kambera, III. 1925, Dr. K. W. DAMMERMAN leg.; 11 ♂, 5 ♀, W. Flores, Laboean Badjo, XI. 1929, natives leg., Dr. J. K. DE JONG don.

Two excellently preserved lots from the Lesser Soemba islands, consisting of both sexes, are present in the Buitenzorg Museum.

FOERSTER's description of the male gives a very good idea of this beautiful insect. In RIS's paper the reader can find a short characterization of both sexes and a more complete diagnosis of the female, described from Timor. As will be seen, however, the female from Timor appears to be rather different from



those of the type locality, and therefore it seems advisable to give a full account on the form occurring in Soemba. Possibly the timorese *selysi* will prove to be sufficiently distinct to give it subspecific rank. Unfortunately I have no material from that island.

♂ ad. (Soemba). — Labium black. Labrum, mandibles and clypeus black, very shining. Face with a transverse convex band running from eye to eye, and covering the whole frons, brilliant scarlet. The posterior border of the two lateral portions of this band slightly irregular and the mid-dorsal black, behind

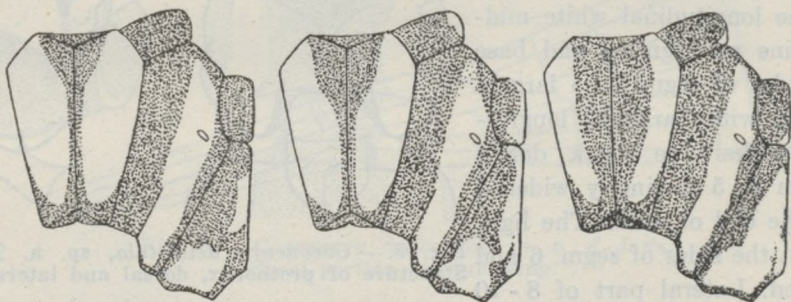


Fig. 9. — *Risioneura selysi* FOERSTER. Colour-pattern of synthorax; a adult male (Soemba), b idem (Flores), c adult female (Flores).

the middle portion, largely protruding in front so as to produce a fine horizontal black line, bordering the base of frons. Head otherwise entirely jet-black. Antennae black. Eyes very dark brown above, olive-brown beneath.

Prothorax black, lateral portion of anterior and median lobes broadly orange red, posterior lobe black. Synthorax brilliant scarlet red above; mid-dorsal line finely bordered with black, this colour suddenly widened in front to form a rather large triangle, as shown on fig. 9a. Mesepimerum black, metepisternum orange red. Metepimerum black, with a large, almost square spot below the hind wing and a much smaller, longitudinal streak in front of it, close to the latero-ventral border. Thorax black ventrally, poststernum palely lined with white. Legs black, interior  $\frac{2}{3}$  of all femora and exterior side of tibiae dirty orange; tarsi dark brown.

Wings hyaline, pterostigma black, oblong, about  $1\frac{1}{2}$  times as long as broad, covering one underlying cell. *Ac* lies exactly at level of *Ax1*, or a spur proximal to it; vestige of *Ab* absent. *Cu1* reaching hinder margin half a cell beyond the nerve descending from quadrilateral in front wing, to the subnodus or a trace before or beyond in hind wing (fig. 10).

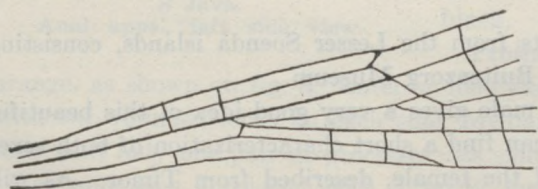


Fig. 10. — *Risioneura selysi* FOERST. ♂ Soemba. Basal portion of hind wing.

Abdomen long and slender, almost completely black, very shining. Sides of segm. 1 and latero-ventral border of 2 narrowly orange. Dorsum of 2 unmarked. Minute transverse orange spots on the dorsum and



very diffuse brownish sub-terminal shades at the sides of segm. 3-6. Segm. 7 black; 8 and 9 largely orange above and at the sides; the mark on 8 occupying nearly the whole dorsum and basal half of sides, that on 9 slightly smaller, only reaching  $\frac{3}{4}$  of the dorsum and  $\frac{1}{3}$  of the sides. Segm. 10 black, with a transverse, orange, mid-dorsal streak.

Anal appendages black. The superiors short, sub-triangular and rather flattened, when viewed from above, each with a large median off-shoot, directed vertically downwards and backwards, narrowed apically and strongly pointed. Inferior appendages much longer; each lateral lobe conspicuous about as long as median process of superiors, interior lobe narrow, both closely approximated in their basal half, then diverging and directed almost horizontally backwards; tips slightly swollen and rounded (fig. 11, Flores).

Length: abd. + app. 31-33, hw.  $19\frac{1}{2}$  -  $20\frac{1}{2}$  mm.

♂ juv. (Soemba). — Light parts of head and thorax dull ivory-white, the dorsal bands showing a greyish green tint whilst the lateral markings are of a delicate ivory-yellow colour. The square spot on the metepimerum and its succeeding line light blue and the dark middle-pieces of abdominal segments 3-6 reddish brown; remaining segments black, but 8-9 with their dorsal markings already orange. — The very curious colour-pattern of the thorax, so markedly different from that shown in the adult stage, gives this insect a very striking appearance. First to appear are evidently the orange marks on the terminal segments of abdomen, last those on thorax and head.

♀ ad. (Soemba). — Labium black, yellowish at base. Anteclypeus dark brown. Coloration of the head as in the male, but the light parts are yellow instead of orange. Eyes as in male. Prothorax marked with yellow. Anterior lobe enormously swollen, directed vertically upwards, divided into two widely separated lobes, when seen from above; each of these lobes at first curled outward and then inwards, to form a scale-like hollowing, on the bottom of which an almost circular concave saucer is inserted. Median lobe convex, simple. Posterior lobe with two pairs of processes; its side-lobes conspicuously raised, widely separated from each other and provided with a long and thin flattened process, directed vertically upwards. The posterior (inner) part consists of two earlike lobes, slightly convergent with their broadly rounded ends and armed with a row of fine denticles on their median border (fig. 12, Flores).

Synthorax deep black with bright yellow markings. Complete almost straight antehumeral bands, and two yellow lateral bands, that on the metepi-

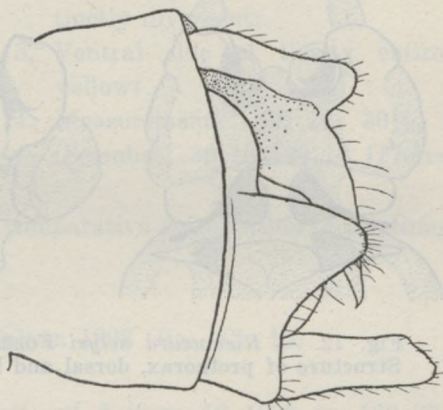


Fig. 11. — *Risioneura selysi* FOERST. ♂ Flores. Anal apps., left side view.



merum being complete and much broader than in the male. Latero-ventral border narrowly blackish (fig. 9c, Flores). Ventral side of thorax yellow. Legs yellowish brown, exterior sides of femora and interior sides of tibiae and tarsi black with bluish pruinescence.

Wings hyaline, neuration as in male (*Cu1* reaching hinder margin at sub-nodus in hind wing). Pterostigma dark brown, a trace longer than in male.

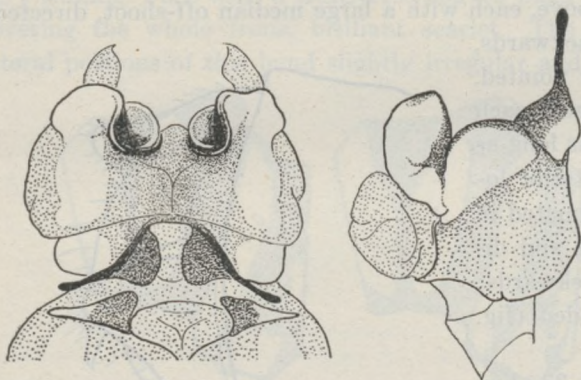


Fig. 12. — *Risioneura selysi* FOERST. ♀ Flores. Structure of prothorax, dorsal and lateral view.

dle. 9 black, largely orange apically, this mark occupying  $\frac{4}{5}$  of the segment on dorsum, about  $\frac{1}{3}$  aside. In the other female the whole dorsum of 8 and 9 is coloured. Segm. 10 and appendages black. Valves dull orange, tipped with black.

Length:  $30\frac{1}{2}$ , 19 mm.

I am unable to detect important differences between specimens from Soemba and Flores. Structure of female prothorax, shape of male anal appendages and neuration are all exactly similar. Only the extension of the orange thoracic markings is slightly but constantly different in the male sex (cf. fig. 9a and b), but not so in the female. Further the coloration on the terminal segments of abdomen is somewhat variable in both series of females, the marks however being always very conspicuous, occupying most of the dorsum. Lastly, the insects of Flores are smaller than those of Soemba, the measurements of the former being: ♂ abd. + app.  $29\frac{1}{2}$ -31, hw. 18-18½; ♀  $28\frac{1}{2}$ -30,  $18\frac{1}{2}$ -19½ mm.

The following distinctive characters of the timorese race of *selysi* are taken from RIs's description: —

#### Timor

1. Dorsal thoracic markings of female narrower, reaching only half up the dorsum; dorso-apical markings

#### Soemba — Flores

1. Dorsal thoracic markings larger in both sexes, in female broad and occupying almost the whole length



on metepimerum reduced to mere triangular spots. Female with terminal light rings on segm. 8-9 narrow;

2. Female with posterior prothoracic processes convergent, strongly bent inward to each other;
3. Ventral side of thorax entirely black;
4. Measurements: ♂ abd. 36, hw. 22, ♀ 36, 23 mm.

of dorsum; dorso-apical markings on metepimerum very conspicuous, often connected with the latero-ventral stripe. Female with segm. 8-9 largely coloured, markings often occupying the whole dorsum;

2. Female with posterior prothoracic processes not bent inward, distinctly divergent;
3. Ventral side of thorax entirely yellow;
4. Measurements: 32, 20; 30½, 19 (Soemba), 30, 18; 29, 19 (Flores).

Other differences can not be given; a comparative examination of the timorese specimens would be desirable.

### **Risioneura fruhstorferi** KRÜGER 1898 (figs. 13-16).

*Alloneura Fruhstorferi* ♂ KRÜGER (*Stett. ent. Zeitung*, 59, 1898, pp. 138-139).

— Hab.: Java.

*Caconeura Fruhstorferi* ♂ RIS (*Abh. Senckenb. Naturf. Ges.*, 34, 1913, pp. 508, 512). — Hab.: Java.

*Caconeura fruhstorferi* ♂ FRASER (*Treubia*, VIII, 3-4, 1926, p. 493). — Hab.: ?Java.

Material studied: 72 ♂, 43 ♀ (partly juv.) Java occ., Batoerraden, G. Slammat, 760 m., 29. V, 10-12. IX, 20-23. XI, 2-18. XII. 1927; 26. II, 14-16. IV, 2-17. V, 8-11. VI, VII, 14-24. VIII, 21. X. 1928; 1. V. 1929. — 7 ♂, 4 ♀ Java mer., isl. Noesa Kambangan, 19-26. IX. 1927; 11. II, 1. III, 22. IV, 7. VI. 1928. — Id., res. Banjoemas, Djeroeklegi, 10-100 m., 20. X. 1929, F. C. DRESCHER leg. — 2 ♂, Id., Preanger, G. Halimoen, 450 m., III. 1927, G. OVERDIJKINK leg. — 2 ♂, 1 ♀, Java or., Idjen plateau, Blawan, 950 m., 29. V, 10-11. VI. 1924, Dr. K. W. DAMMERMAN leg. — 5 ♂ ad., Falls at foot of G. Pakiwang, Lake Ranau, Sumatra mer., ca 500 m., 30-31. X. 1929, Mrs. M. J. VAN STEENIS leg. — 2 ♂, 1 ♀ (in cop.), G. Tanggamoos, forest-reservate Oeloebeloe, ca. 300 m., and Kotaagoeng, Lampongs, Sumatra mer., 31. III. and 2. VI. 1929, F. C. DRESCHER leg.

Allotype, G. Slammat, 16. IV. 28.

♂ ad. — Labium black, slightly whitish at base. Face shining black with a transverse orange band running from eye to eye, covering frons and postclypeus as in *selysi*. At the side of each lateral ocellus a minute spot dull orange. Head otherwise black. Antennae black. Eyes dark reddish brown.

Prothorax and synthorax marked with bright orange, as described by KRÜGER. In all specimens examined by the author the light fascia covering the



mesepisternum reaches half-way up the dorsum (not: "... oben vor dem Rande aufhörend", as stated by KRÜGER). (fig. 13a).

Wings usually hyaline, but in very old specimens distinctly yellowish, especially in the anterior part of the wing. Pterostigma black, oblong, about  $1\frac{1}{2}$

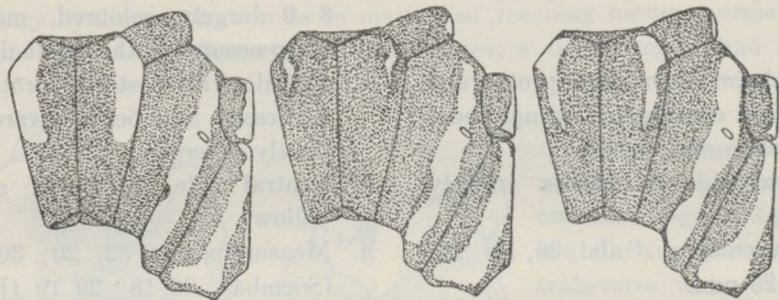


Fig. 13. — *Risioneura fruhstorferi* KRÜG., Java.  
Colour-pattern of synthorax; a. adult male, (Slamat), b. large female ad., idem, c. small female ad., (Noesa Kambangan).

times as long as broad, covering one cell. Position of *Ac* as for genus; vestige of *Ab* absent. *Cu1* reaching hinder margin less than half a cell beyond the nerve descending from quadrilateral in front wing, about  $1\frac{1}{2}$  cell in hind wing, but never reaching subnodus (fig. 14).

Abdomen very long and slender, black. Segm. 1 with a lateral orange spot, 2 with two rounded dorsal spots of the same colour at base, a light streak

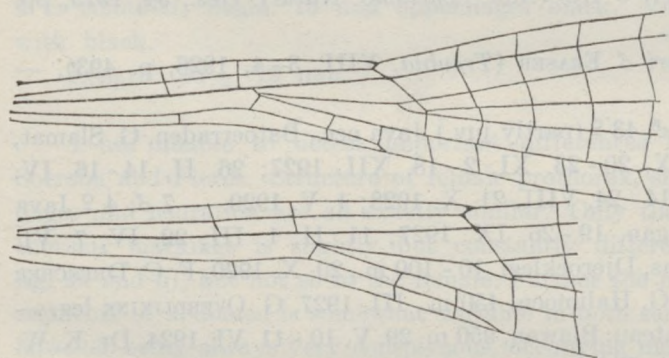


Fig. 14. — *Risioneura fruhstorferi* KRÜG., Java.  
Basal portion of hind wing; a. small ♂ (Noesa Kambangan), b. large ♂ (Slamat).

above genitalia and a minute spot on each side near the end of the segment. On segm. 3 only paired basal spots are sometimes visible. Dorsum of 8-9 largely sky-blue, on 8 the apical  $\frac{1}{5}$ , on 9 the apical half remains black. Segm. 10 and appendages black. Superior appendages short, each with a large median

tooth, directed downwards and backwards. Inferiors longer, each divided into exterior and interior parts, the latter being longest and closely approximated (fig. 15 and Pl. 7, fig. 4 in RIs's paper).

Length:  $31\frac{1}{2}$  - 38,  $19\frac{1}{2}$  -  $24\frac{1}{2}$  mm.

The female has not yet been described. The following lines may characterize it.

♀ ad. — Light markings on head as in male, the orange colour less intensive, often pale whitish, but in fresh and adult females dull orange. Labrum and



black portion of frons very shining. Prothorax marked with orange. Shape of anterior lobe much as in *selysi*, swollen, directed upwards and divided into two separated lobes, when seen from above; each of these lobes bent outwards laterally, then curled inwards, to form a scale-like hollowing, its anterior part furnished with a deeply concave appendix, bright yellow in colour. Median lobe slightly convex. Posterior lobe with two pairs of processes; its side-lobes widely separated from each other, raised and provided with a rather long, flattened process, directed vertically upwards. The posterior (inner) part consists of two ear-like lobes (fig. 16, Noesa Kambangan).

Synthorax deep black but with a distinct coppery-red reflex, especially above. Thoracic markings orange above, lighter at the sides. Antehumeral band incomplete, fairly broad at base but soon narrowed and pointed, extending at a maximum slightly less than half-way up the dorsum; in many other specimens the lines are reduced so as to be almost absent. Complete orange band on metepisternum and a second on metepimerum, widened below the wing base. Posterior half of latero-ventral border black (fig. 13b-c). Ventral side of thorax entirely yellow. Legs black, interior sides of femora yellowish brown, exterior sides of tibiae reddish.

Wings hyaline, neuration as in male. *Cul* sometimes reaching subnodus in hind wing. Pterostigma dark brown, less than  $1\frac{1}{2}$  times as long as broad.

Abdomen almost completely black, even at the sides and underneath. Segm. 1 with a large yellow spot aside and 2 with two very small basal spots on the dorsum. Minute transverse yellow points at base of segm. 3 only. Dorsum of 8

with a large circular or somewhat triangular basal marking, blue in colour and occupying  $\frac{1}{3}$  -  $\frac{3}{4}$  of the segment. Abdomen otherwise black, except a light point at base of valves.

Length extraordinary variable:  $29\frac{1}{2}$  -  $36\frac{1}{2}$ , 22 - 26 mm.

The smallest fe-

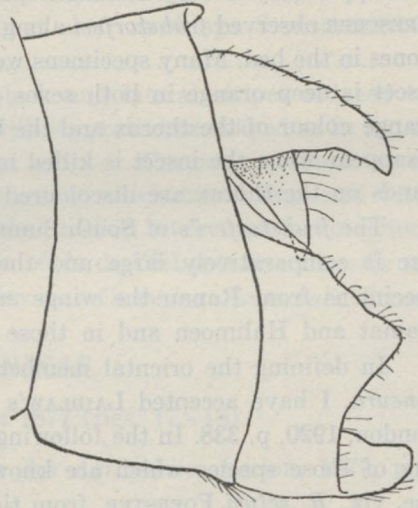


Fig. 15.—*Risioneura fruhstorferi* Krüg., ♂ Java. Anal app., left side view (Slamat).

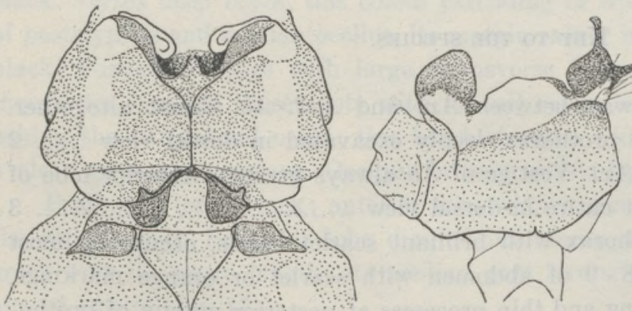


Fig. 16.—*Risioneura fruhstorferi* Krüg., ♀ Java. Structure of prothorax, dorsal and lateral view (Noesa Kambangan).



male which I have seen measures only abd. 28, hw.  $19\frac{1}{2}$  mm. It has rather long antehumeral stripes, but on the metepimerum the dorsal portion of the light fascia is isolated and reduced to a triangular spot. The light markings on thorax and abdomen are of a light greenish colour, but the band across the frons is distinctly orange. This example was taken on the island Noesa Kambangan and agrees with all other specimens taken there in its small size, comparatively long antehumeral lines and reduced metepimeral band.

I have chosen one of the large females from G. Slamet as the allotype of *fruhstorferi*.

Apparently a very common species on suitable places. On G. Slamet Mr. DRESCHER observed *fruhstorferi* along much slooping mountain-brooks with heavy stones in the bed. Many specimens were taken in copula. The colour of the living insect is deep orange in both sexes, alternated with black and clear blue. The orange colour of the thorax and the blue spots on the terminal segments rapidly disappear when the insect is killed in acetic ether; in most of the specimens the bands on the thorax are discoloured and faded.

The *fruhstorferi*'s of South Sumatra do not differ from those of Java; their size is comparatively large and the colours are beautifully preserved. In all specimens from Ranau the wings are dark yellow, as in some males from G. Slamet and Halimoen and in those from the Idjen plateau in E. Java.

In defining the oriental members of the old genera *Disparoneura* and *Caconeura*, I have accepted LAIDLAW's arrangement, proposed in Proc. Zool. Soc. London, 1920, p. 338. In the following key I have arranged the principal characters of those species which are known to occur in Java, with the addition of one, viz., *R. selysi* FOERSTER, from the Lesser Soenda Islands. The type-locality of *C. lansbergei* SELYS is unknown, but FOERSTER (Ann. Soc. ent. Belg., XI, 1896, pp. 424-425) described the presumed female from Java. It seems better to ignore this species until exact material is available. The diagnosis of *C. humeralis* SELYS is taken from the original description; it seems very rare in Java and I have seen not a single specimen of it. The only Javanese record of it is Moela, G. Sewoe, E. Java, 1 ♂, II.1911, E. JACOBSON leg. (cf. RIS, Tijdschr. v. Ent., 55, 1912, p. 161, Pl. 7 fig. 3 — anal appendages).

#### KEY TO THE SPECIES.

1. *Ac* situated about midway between *Ax1* and *Ax2*. *Ab* absent altogether. Anterior lobe of female prothorax deeply excavated in dorsal view ..... 2
- Ac* situated at level of *Ax1*. Vestige of *Ab* always present. Anterior lobe of female prothorax almost entire in dorsal view ..... 3
2. ♂ Episternum of mesothorax with brilliant scarlet bands, occupying most of the dorsum; segm. 8-9 of abdomen with scarlet or orange markings. ♀ with a pair of very long and thin processes at posterior margin of prothorax and with complete light bands on mesepisternum. Lesser Soenda Islands

*Risoneura selysi* FOERST.



♂ Episternum of mesothorax with incomplete pale or orange bands, occupying the lower half of dorsum; segm. 8-9 of abdomen with clear blue markings. ♀ with a pair of short and thin processes at posterior margin of prothorax and with light bands on mesepisternum much reduced. Sumatra, Java

*Risioneura fruhstorferi* KRÜG.

3. Coloration of male bright orange and black; head with two light bands from eye to eye. Episternum of mesothorax almost entirely orange. ♀ with straight and broad antehumeral lines and with its prothorax shaped as in fig. 8. Java ..... *Caconeura delicatula* sp.n.

Coloration of male almost entirely black, or episternum of mesothorax with only narrow carmine stripes; head without clear markings. ♀ with narrow but complete antehumeral lines ..... 4

4. ♂ Episternum of mesothorax entirely black and lateral stripes reduced to mere traces (ad.). Coloration whitish. ♀ with its prothorax shaped as in fig. 4. Java ..... *Caconeura corvina* sp.n.

♂ Episternum of mesothorax with fine carmine antehumeral lines and with lateral stripes brown. ♀ Prothorax: "lobe médian avec une tache livide, le postérieur très-largement échancré, les côtés de l'échancrure redressés en deux lobes étroits" (SELYS). Malacca, Java ... *Caconeura humeralis* SELYS

#### Subfam. AGRIONINAE.

#### **Agriocnemis minima** SELYS 1877 (figs. 17-18).

*Agriocnemis minima* SELYS ♂ (*Synopsis des Agrionines*, Agrion, 1877, pp. 51-52). — Hab.: Java.

*Agriocnemis minima* ? KRÜGER ♂ (*Stett. entom. Zeitung*, 59, 1898, p. 126). — Hab.: Penang.

Material studied: 3 ♂ semiad., Java mer., res. Banjoemas, Patimoean, 9.III.1929, F. C. DRESCHER leg. — 1 ♂ ad., Java (Mus. Brussels). Holotype.

♂ semiad. (Patimoean). — Ventral side of head and labium yellow. Genae and base of mandibles yellowish green. Labrum black, very shining, its anterior part bright yellow. Frons and anteclypeus clear grass-green, postclypeus shining black. Vertex deep black, this colour extending in front to a level between base of postclypeus and median ocellus, its margin rather irregular in front. Antennae black. Postocular lobes with large, transverse 7-shaped spots, lying down on their sides, each of these spots with its tail separated from a transverse band behind the two lateral ocelli; this band of equal width and all three marks of a clear grass-green colour. Occiput largely green. Eyes dark brown.

Prothorax long, black; anterior lobe wholly green, sides of median lobe of the same colour. Posterior lobe divided into three parts, finely bordered with green over its entire length; its median part strongly projecting, not elevated, almost square (fig. 17).

Synthorax grass-green and black; dorsum black with straight, narrow antehumeral lines. Humeral black band of equal width as each of the median



black parts. Antealar sinus with its anterior margin green. Sides grass-green, dorsal end of second lateral suture with a conspicuous oval black spot. Ventral side of thorax clear yellow. Legs clear yellow, exterior sides of femora with a thick black band, almost touching the base of each. Interior sides of tibiae black at base; ends of tarsal joints and spines black.

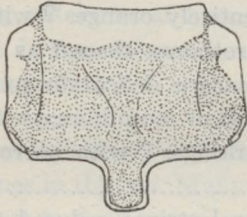


Fig. 17. — *Agriocnemis minima* SELYS, ♂ Java. Structure of posterior lobe of prothorax.

Wings very short. Neuration light ochreous. Post-nodal index:  $\frac{5.5}{4.4}$ . Pterostigma rather high, clear orange between black nervures, not entirely covering one underlying cell.

Abdominal segments 1-7 green with bronzed black markings; 8-10 orange and black. Segm. 1 with a square black mark occupying the whole dorsum, articulation green; 2 with broad dorsal mark from base to apex, enclosing two stretched-oval windows just before the middle of the segment. This black marking overlapping a part of the sides, strongly constricted before the apex, connected with the distal margin of the segment by a short stalk-like longitudinal stripe. Segm. 3-5 with gradually enlarged longitudinal stripes on the dorsum from base to apex, each of them being slightly constricted at base, considerably widened before the end and finally again constricted. On segm. 6 and 7 this black band is only constricted at the base of each. Articulations black. Segm. 8-9 gradually widened towards their apices, 8 with its basal half black above, fading into bright orange; 9-10 entirely orange, save for a small mid-dorsal triangular black spot at base of 9 and a narrow black margin at base of 10.

Anal appendages orange, marked with black and shaped as in fig. 18.

Length: abd. + app. 15 - 15 $\frac{1}{4}$ , hw. 9 $\frac{1}{2}$  - 9 $\frac{3}{4}$  mm.

I have compared the fresh males from Patimoean with the type specimen in Mus. Brussels, with which they perfectly agree. There are but slight discrepancies as regards colour, because the type is fully mature, showing a distinct blue coloration, whereas this is replaced by grass-green in the additional males. The terminal abdominal segments of SELYS's specimen however, are still orange and black. The size too is a trifle larger in the new examples. — This stage of maturation is possibly comparable with that demonstrated in males of *femina* BR., showing their

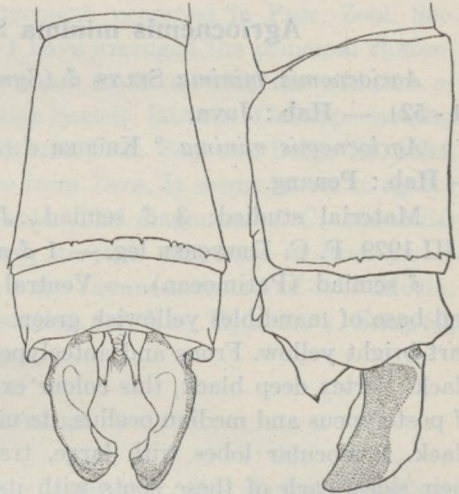


Fig. 18. — *Agriocnemis minima* SELYS, ♂ Java.

Anal apps., dorsal and lateral view.



terminal segments of a bright orange red colour. Almost everywhere in Java I observed red males of *femina* in company with adult specimens with their abdomen completely darkened and with thorax densely powdered with white. I am therefore inclined to suspect a corresponding development of the colour-pattern in the present species.

KRÜGER's record of a male *minima* (loc. cit.) taken in Perak seems rather doubtful. It is possible that he has examined a true *nana* male; indeed the two species are very closely allied, though certainly distinct.

### ***Agriocnemis* ? *nana* LAIDLAW 1914 (figs. 19 - 20).**

*Agriocnemis nana* ♂ LAIDLAW (*Rec. Ind. Mus.*, 8, 1914, p. 348, Pl. XVI, fig. 10). — Hab.: Kachin Hills, Upper Burma.

*Agriocnemis minima* ? ♂ KRÜGER (*Stett. entom. Zeitung*, 59, 1898, p. 126). — Hab. Penang.

4 ♂ ad., Malacca, Perak, Kwala Kangsar, B. JACHAN vend. (Mus. Hamburg).

♂ ad. — Labium whitish. Labrum shining blue, with its basal part sharply defined black. Face, including clypeus and base of mandibles, light blue. Vertex deep black, this colour extending in front to a level slightly before the base of antennae, touching base of postclypeus mid-dorsally and including the frons. On either side behind the blue postclypeus a narrow blue off-shoot, projecting inwards. Dorsal surface of head otherwise bronzed black, very shining. Antennae reddish brown. Postocular spots blue, slightly narrower and more elongated than in *minima*, touching a blue transverse band of equal width, lying behind the ocelli. Occiput largely pale blue. Eyes dark brown.

Prothorax long, black; anterior lobe blue, sides of median lobe pale greenish blue. Posterior lobe divided into three parts, finely margined with citron-yellow; its median lobe pale greenish blue. Posterior lobe divided concave in front, scale-like and slightly elevated, its posterior margin slightly notched (fig. 19).

Synthorax slender, with very narrow, straight blue antehumeral lines. Humeral black bands and antealar sinus as in *minima*. Sides bluish white, a small blackish spot at dorsal end of second lateral suture. Ventral side whitish.

Coxae and legs white. Distal  $\frac{2}{3}$  of exterior sides of femora black, spines dark reddish brown.

Wings excessively short, reticulation pale. Postnodal index  $\frac{5.5}{4.4}$ . Pterostigma much narrower than in *minima*, white between black nervures; lower half much darker than its upper portion and covering one underlying cell.

Abdominal segments 1 - 10 clear blue, marked with bronzed black. Segm.



Fig. 19. — *Agriocnemis* ? *nana* Laid. ♂ Perak. Structure of posterior lobe of prothorax.



1 - 2 with dorsal black markings very similar in shape to those in the foregoing species, but narrower and only occupying the dorsum of the segment. Segm. 3 - 5 with longitudinal lines narrow, restricted to the dorsum, the dorso-lateral blue broadly visible as seen from above, especially so on dorsum of segm. 4 - 5. Before the end of each segment the dorsal black suddenly widens to form a transverse umbrella-shaped line, partly covering the sides, this mark followed again by a strong constriction, the black finely connected with the articulation.

On segm. 6 the dorsal black stripe is somewhat broader, narrowed in front, widened before the end and broadly connected with the articulation. Segm. 7 with an elongated black line only occupying the dorsum and not reaching the apical margin of the segment, ceasing at about  $\frac{2}{3}$  -  $\frac{3}{4}$  of its length, bluntly pointed. Segm. 8 blue with a pointed triangular black mark at base, occupying  $\frac{1}{5}$  of its length. 9 blue with a large black ring, almost occupying the whole segment, whilst the latero-ventral and apical margins remain blue. 10 blue with a narrow transverse black line at base, somewhat more extensive aside.

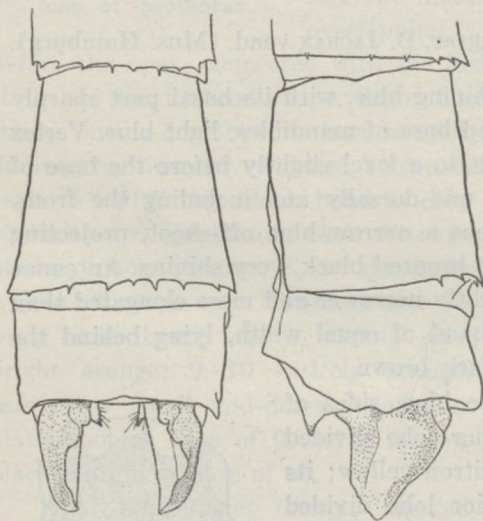


Fig. 20. — *Agriocnemis* ? *nana* LAID.  
♂ Perak.

Anal apps., dorsal and lateral view.

Anal appendages largely blue, the superiors marked with black exteriorly, with yellow inside; in natural position shaped as in fig. 20. From the ventral margin of each of the superiors depends a large hook-like structure, which is directed downwards and at its apex slightly outwards and backwards, with a crescentic posterior margin. Inferior appendages with a diamond-shaped incision, when viewed from aside and with pointed tips (cf. LAIDLAW's fig. 10, l.c.).

Length: abd. + app.  $14\frac{1}{2}$ , hw.  $8\frac{3}{4}$  mm.

The quite numerous representatives of the *minima*-group to which *nana* also belongs, all seem to differ but slightly from each other, though we may suppose that most of the described species are really distinct. As follows from the description the specimens of *nana* from Perak do not sufficiently agree with LAIDLAW's account on specimens from Upper Burma and therefore I originally described them as new. When examined in their natural position the superior anal appendages seem to be completely devoid of a proximal tooth at their ventral margin, but a closer examination brought to light that a well-developed tooth-like projection is really present, though only visible in moistened or living examples in which the appendages can be moved and voluntarily flexed. Therefore much hesitation was excited by LAIDLAW's figure of the terminal segments of *nana* — apparently not drawn from a specimen which was intention-



ally prepared for this purpose! Moreover FRASER in his paper on Indian Odonata in the Pusa collection (Mem. Dept. Agric. India, 7, 1922, pp. 52 - 55, Pl. 6 fig. 1,4) described both sexes of two additional new species belonging to the group, viz. *A. d'abreui* and *A. clauseni*, from Assam, of which *d'abreui* seems to be quite distinct but *clauseni* is said by the author to be very much related to *nana* LAID. This species is characterized in having its frons and its terminal abdominal segments very dissimilarly coloured and, besides, in having no less than 9 post-nodal nervures in the front wing. FRASER's figure of the male appendages however, is very similar to that given in the present paper for *nana*, though in *clauseni* the proximal tooth is again very clearly shown and nothing is said about the position of it looked at *in situ*. However it may be, I do not dare to theorize in this respect and it seems wise for the present to regard all species as distinct. I refer my specimens to *nana* with much doubt, giving the differences in a table, as follows: —

<i>nana</i> (Burma)	? <i>nana</i> (Penang)
1. Frons blue with a black line;	1. Frons black;
2. Segm. 7 of abdomen with a complete dorsal black line; 8 with a black mark confined to the dorsum for its first half, for the second half it expands on to the sides of the segment; 9 - 10 almost entirely black save for a small blue area on the lower parts of the sides of 9;	2. Segm. 7 of abdomen with dorsal black line incomplete, ceasing at $\frac{2}{3}$ - $\frac{3}{4}$ of its length; 8 entirely blue, save for a small triangular basal spot at base on the dorsum, occupying most of the segment; 10 blue, with a narrow line at base, somewhat enlarged aside;
3. Superior anal appendages bluntly conical with their ventral hook-like projection at base rather rounded apically;	3. Superior anal appendages almost pointed, with their ventral projection at base pointed apically;
4. Length of abdomen (incl. apps. ?) 18, of hind wing 9 mm.	4. Length of abd. + app. $14\frac{1}{2}$ , of hind wing $8\frac{3}{4}$ mm.

The two forms may ultimately prove to represent distinct races of a single species. It may be noted that the present example is perhaps the smallest of all living Odonata!

### ***Teinobasis helvola* sp. n. (fig. 21).**

1 ♂, 1 ♀ ad. (in cop.), S. Celebes, Maros, VI. 1929, G. OVERDIJKINK leg. Allied to *tenuis* MARTIN.

♂. — Labium, base of mandibles and genae whitish. Labrum entirely black. Anteclypeus whitish, postclypeus shining jet-black with its anterior border nar-



rowly white. Dorsal surface of head and postocular space dark greenish bronze, almost black; area behind the ocelli slightly pruinose. Occiput and lower surface of head yellowish. Basal joints of antennae white. Eyes bright olive-green.

Prothorax and synthorax golden-red above, with distinct pinkish huge; light pinkish to almost white at the sides. All sutures bluish pruinose, including margins of prothorax and dorsal ridge of episternum of mesothorax, along which it is developed as fine bluish white lines. Posterior border of prothorax slightly elevated, straight and completely rounded. Hinder margin of antealar ridge broadly black. Coxae and legs pale yellow, terminal half of exterior sides of femora diffusely brown; spines short, black at base. Tarsal claws without teeth. Ventral side of thorax white, evenly powdered with bluish white.

Wings hyaline. *Ac* situated much nearer the level of the second antenodal cross vein than to the first (about 1 : 6). *MS* and *Rs* arising at subnodus, very close together but separate at their origin for a length of about one cell, then gradually diverging. Postnodal index  $\frac{17.17}{15.15}$ . Pterostigma smaller than one underlying cell, slightly oblong, black, bordered with yellow between black nervures.

Abdomen long; segm. 1-2 and extreme base of 3 pale red, dorsum of 3-7 black, rather buff, this colour overlapping the sides for their terminal  $\frac{1}{6}$ - $\frac{1}{7}$  parts, forming black annules. Narrow yellowish basal rings on segm. 4-7 and olive-green or yellowish green sides. Distal  $\frac{1}{5}$  of segm. 7 and remaining segments, including anal appendages, entirely orange-red. Posterior border of segm. 10 strongly elevated, showing in its middle an arch-like projection, blackish enfumed at its acute margin; below this structure two small tooth-like lobes project from the almost vertical inner side of the segment. Anal appendages as in typical *Teinobasis*; upper branch of superiors short, knob-like and rather rounded; lower branches much longer, though shorter than the inferior appendages, gently curved upwards with black tips. Inferior appendages longest, thick

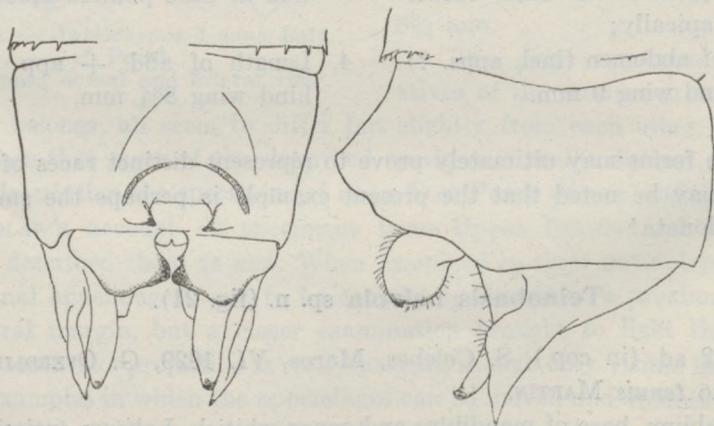


Fig. 21.—*Teinobasis helvola*, sp. n. ♂ Celebes.  
Anal apps., dorsal and lateral view.



at base, distinctly swollen in their middle and finally tapering and much pointed, their tips nearly straight (fig. 21).

Length: abd. + app. 39, hw.  $25\frac{1}{2}$  mm.

♀. — Very similar to the male, but much larger and with its colours more quiet. Labrum dull orange, with a thick black border at base, widened in front to form a spot-like mark. Anteclypeus whitish, postclypeus black, except its centre which is dull orangish. Head otherwise as in male. Vertex slightly pruinose. Posterior border of prothorax exactly as in male. Prothorax and synthorax cinnamon-coloured above, dull yellowish at the sides; all sutures pruinose as in the other sex, including medio-dorsal ridge of mesepisternum and humeral suture, along which it is especially developed. Ventral side of thorax and legs pale yellow; no black streaks at femora.

Wings hyaline, neuration as in male. Postnodal index  $\frac{17.17}{16.16}$ . Pterostigma dark grey brown, broadly bordered with yellow between black nervures.

Abdomen very long, rather robust. Ground-colour dull greenish yellow; dorsum of segm. 1 - 7 with black longitudinal bands, those on segm. 1 - 3 narrower than on the following segments and with slight metallic shine; these bands slightly constricted at base of segm. 3 - 6, widened before the end of each. On segm. 2 this mark is not sharply limited apically and ceases before the posterior border of the segment, whilst its sides are diffusely reddish green. Apical  $\frac{1}{3}$  of segm. 7 reddish, the terminal black on dorsum ill-defined. Segm. 8 - 10, including appendages and valves orange red, unmarked.

Length: abd. 45, hw.  $30\frac{1}{2}$  mm.

This species falls in RIs's group IA, together with *T. superba* SELYS and *tenuis* MARTIN. From the former it is readily distinguished by the absence of any dark markings on synthorax and by the different shape of male anal appendages (cf. RIs's fig. 22 in Nova Guinea, 13, 2, 1915, p. 100, 104).

In the male of *tenuis* the lower branch of the superior appendages is longer than the inferiors, whilst in *helvola* it is so in inverse proportion. Moreover the upper branches of the superiors are different in both species. Pale blue or whitish antehumeral bands, recorded by MARTIN and RIs for *tenuis* are wholly absent in the present species.

The considerable difference in size between the two sexes of this species is noteworthy, as it throws some light upon the extreme variability in size of some *Zygoptera*.

*T. helvola* is the third representative of the genus in Celebes.

#### Subfam. CORDULIINAE.

#### *Hemicordulia tenera* sp. n. (fig. 22).

1 ♂ ad., Java occ., res. Banjoemas, G. Slamet, Batoerraden, 760 m, 14.II.1929, native leg., F. C. DRESCHER.



Small, slender species, with weak integument.

♂ (Holotype). — Head large. Labium pale yellow, labrum dull orange. Clypeus dirty olive-brown. Frons with its ventral part only slightly flattened, rounded above and of a brilliant metallic green colour; lower half of the sides, against the eyes, and its anterior margin sharply defined olive-brown. Vertex rounded, bright metallic green. Occipital triangle conspicuous, its distal margin projecting and tumid posteriorly, slightly notched in its middle, chestnut-brown and very shining. Occiput otherwise shining black. Eyes brown.

Synthorax slender and very narrow, brilliant metallic green above and at the sides. Lower  $\frac{1}{3}$  part of dorsum, meso- and metinfraepisternum reddish brown, without metallic lustre. Obscure brownish fascia showing through the metallic colouring on metepisternum and hinder part of metepimerum, very gradually turning to the metallic green ground-colour. Ventral side of thorax reddish brown, the metallic green areas more sharply defined at latero-ventral border than aside, the band along second lateral suture about 0.6-0.8 mm. broad, slightly diminishing ventrally. Antealar ridge and spaces between the wings brown. Legs very long and slender; coxae brown, trochanters and anterior sides of fore and middle legs dark reddish brown; otherwise black. Length of middle and hind femora, inclusive trochanters, 6.8 and 8 mm, respectively; of tibiae 5 and 7 mm. Tibial lamina dark brown, along distal  $\frac{2}{3}$  of first pair, absent on second pair and along full length of third pair.

Wings evenly and distinctly saffronated all over, especially in basal half of hind wing. Neuration and pterostigma very dark reddish brown, almost black.

Nodal index:  $\frac{5.7.7.5}{7.5.5.7}$ . Cells between  $R_s - Rspl$   $\frac{4.5}{4.5}$ . Membranula reddish.

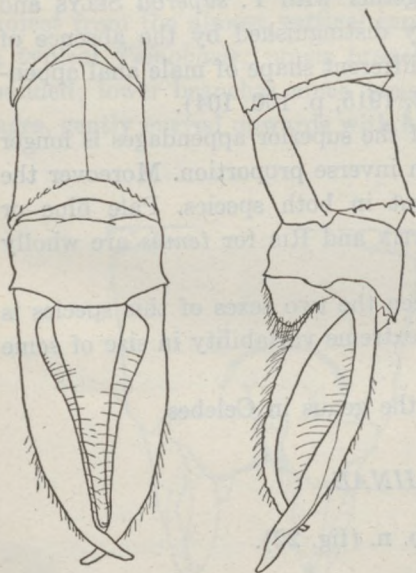


Fig. 22. — *Hemicordulia tenera*, sp.n.  
♂ Java.

Anal apps., dorsal and lateral view.

Abdomen slender, almost cylindrical, not enlarged towards the end and not constricted at base; first two segments only very slightly widened. Segm. 1-2 dark brown, very shining, with traces of diffuse lighter spots aside. Auriculae absent, their places indicated by an almost invisible thickening. Segm. 3-10 very dark bronzed black, buff, without any indication of yellow markings, save for a very diffuse dorso-lateral lightening at margin of 7-8. Segm. 3 very shining, especially along latero-ventral border. Ventral parts of tergites narrowly margined with reddish and basal  $\frac{1}{3}$  of segm. 7-8 likewise. Sternites black. Anal appendages weakly built, almost transparent, long and very slender, the superiors distinctly swollen in the middle and almost circular in



diameter, black at base and at the tips, otherwise reddish brown (fig. 22).

Length: abd.  $< 31 + 3.5$ , hw.  $29 : 10$ , pt.  $\frac{1.6}{1.4}$  mm.

The present species recalls *H. silvarum* Ris rather closely, showing undeniable affinities to that delicate species. The male is easily recognizable by the different shape of its caudal appendages and by its more brilliantly coloured thorax, the brown markings on it being very inconspicuous and replaced by metallic green. Its buff, almost black abdomen strongly contrasts with the brightly coloured rest of the body. The very thin and long legs are further noticeable. — Certainly a shade- and jungle-loving species, probably breeding in small bogs or ponds in dense forest. It was taken by chance, together with a series of *Procordulia sumbawana* and *Macromia westwoodi*.

The female remains unknown.

***Procordulia artemis* sp. n. (figs. 23 - 25).**

Material studied: 13 ♂, 2 ♀ ad. Java occ., G. Tangkoeban Prahoe, ca. 1500 m., 21.I, 8-20.V, 7.VIII, 23.IX, 7-26.X and 9.XI.1929, F. C. DRESCHER leg.

Several males ad., Id., Poentjak Pass, Telagawarna, ca. 1450 m., 30.III and 4.V.1930, M. A. L. leg. — 15 ♂, 2 ♀ ad., Id., Kawah Kamodjan near Garoet, 1650 m., 19.IV.1930, M. A. L. leg.

A small slender species of dark coloration, with broad and much pointed wings.

♂ ad. — Labium pale yellowish white. Mandibles and labrum dull orange, the latter with a rather defined squarish brown spot at base. Clypeus olive-brown. Frons much rounded anteriorly, its vertical portion granular, bright ferruginous in the middle, fading into dark olive-brown aside; upper portion brilliant metallic green as far as its anterior margin. Depression between frons and vertex deep. Vertex high, rounded aside, straight and truncated when seen in front, metallic green. Triangle and occiput dark brown, the latter slightly convex behind, very shining. Eyes emerald-green during life, very dark brown in dried specimens.

Synthorax rather robust, brilliant metallic green all over; in not fully mature specimens the metallic shine on mesinfraepisternum and metepisternum is intermingled with the dark reddish-brown ground-colour. Ventral side of thorax and spaces between the wings dirty reddish brown.

Legs long and slender, trochanters and anterior side of fore and middle legs dark brown. Legs otherwise black. Length of middle and hind femora, inclusive trochanters, 6.9 and 8.2 mm., respectively; of tibiae 5.8 and 7.2 mm. Tibial lamina dark brown, along distal half of first pair, absent on second pair and along distal  $\frac{1}{7}$  -  $\frac{1}{8}$  of third pair.

Wings comparatively short, broad at base and rapidly tapering, the tips much pointed. Almost hyaline with a very slight yellowish tint covering the whole surface. In very old males irregularly spotted with dark rusty amber. Base of hind wings with an ill-defined amber spot in the anal triangle not extending



beyond cubital cross vein. Neuration very similar to that in *sumbawana*, nervures black. Pterostigma very small, in hind wing a trace shorter than in front. Membranula dark grayish black, somewhat lighter at extreme base.

Nodal index very variable. Antenodal cross veins in front wing 7-8 (70 % with 7), in hind wing always 5; postnodal cross veins in front wing 5-6 (65 % with 5), in hind wing 5-7 (about equally distributed, very rarely 8: two males in left hind wing). Triangles of front wing always traversed by one cross vein, of hind wing always free. Subtriangles in nearly all specimens three-celled, very rarely two-celled. Only one cross vein in cubital space, without exception. Radial supplement short, ordinarily 5 cells between *Rs-Rspl* in front wing, 6 in hind wing. Arculus oblique, in all specimens situated in the middle between first and second antenodal cross vein. Anal angle much rounded; triangle with a short vein in its apical third.



Fig. 23. — *Procordulia artemis*, sp. n.  
♂ Java.  
Left side view of genitalia; hair omitted.

Abdomen very slender, slightly constricted in the middle of segm. 3, then gradually enlarged towards the end of segm. 6 where it is broadest (3.4 mm.), finally narrowing again from the base of 7 to the end. Basal segments slightly swollen, much higher than wide, greatest width about 3 mm. Segm. 3-5 rounded above, then subtriangular in diameter, from about the middle of segm. 6 to the end of 9 with a distinct median longitudinal crest. Venter perfectly flattened. Tenth segment without crest on dorsum, about 1.5 mm. broad at base. Auriculae very small, knob-like, shining black.

Coloration dark bronzed-black, first three segments with distinct metallic green shine; middle segments with slight coppery-red reflex and terminal ones almost black. Segm. 5-8 with indistinct dull orangish streaks along the latero-ventral carina, on dorsum; these stripes very inconspicuous and badly defined in mature specimens. Otherwise unmarked. Sides of segm. 1-2 and basal half of 3 very shining. Ventral side of tergites dull brownish, their terminal fifth darkened.

Genitalia on second segment not very prominent, black in colour. Genital lobe subtriangular in general outline. Posterior hamuli much shorter than the lobe, usually partly invisible when seen from aside, thick at base, then constricted and considerably narrowed, strongly bent with rounded apex, straight in the median plane. Pile rather long and thin, white (fig. 23).

Anal appendages weakly built, very slender, black. The superiors about as long as segm. 9 + 10, widely separated at base where they are divergent for a short distance, thence bending inwards and meeting each other in their distal third, running straight and closely parallel towards the end. Tips very slender, rounded, each of them with a small bunch of very strong hair so as to give it a superficial appearance of being acutely pointed. Inferior appendage about  $\frac{5}{6}$  as long as superiors, long-winded triangular (fig. 24).



Length: abd. + app. 36-38, hw. 34-35, pt.  $\frac{1.8-9}{1.7}$  mm.

♀ ad. — Very similar to the male but differing in the following respects: —

Face uniform dull brownish, labrum usually less brightly coloured, its basal brown mark ill-defined. Vertical portion of frons in one female coloured as in the male, in the others dirty brownish; its upper portion less metallic. Eyes chestnut-brown, as also the occiput and a streak behind the eyes; otherwise black. Colour of synthorax and legs as in the male.

Wings palely saffronated all over. Basal yellow spot in cubital space inconspicuous (In one female the wings are distinctly cloudy yellow and the basal spot is more distinct). Neuration as in male; position of arculus similar in all

four specimens. Nodal indices:  $\frac{5.8.8.5}{6.5.5.6}$ ,  $\frac{6.7.8.6}{7.5.5.7}$ ,  $\frac{6.9.9.6}{7.6.6.8}$ ,  $\frac{5.7.8.5}{6.5.5.6}$ .

Pterostigma black.

Abdomen short and robust, almost parallel-sided for its entire length. Terminal segments very gradually and but slightly narrowed. Venter flattened. Basal segments slightly swollen, third segment not constricted. Coloration very dark blackish brown, segm. 2-3 slightly metallic green above, very shining aside. Remaining segments with coppery-red and purplish reflex as far as the end of segm. 6. Dull orangish, rather buff longitudinal streaks along latero-ventral margin of 4-8 broader than in male, these stripes not reaching the apical margins of the segments; on 6-7 each spot is narrowly divided into two parts by a very fine transverse black line connected with the dorsal black. Ventral surface as in male.

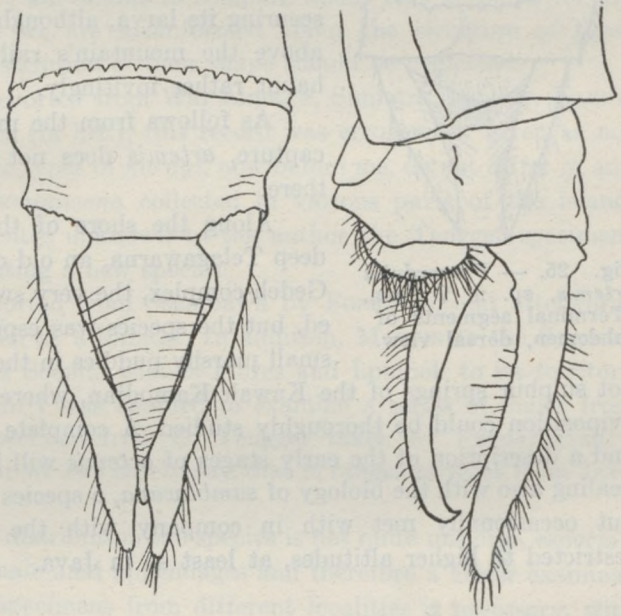


Fig. 24. — *Procordulia artemis*, sp. n. ♂ Java. Anal apps., dorsal and lateral view.

Vulvar lamina with its upper margin slightly projecting ventrad when seen in profile, about as long as ninth sternite, which is prolonged well beyond the tergal margin, broader than long, its free margin triangularly notched, the lobes rounded and not widely distant, the surface with a longitudinal depression.

Anal appendages black, very slender and distinctly shorter than segm. 9 + 10 (about as long as segm. 9), gradually tapering towards the end, the tips almost pointed (fig. 25).



Length: abd. excl. app. 32-35, hw 35, pt.  $\frac{1.7}{1.6}$  mm.

The chief differences between this and *sumbawana* FOERSTER have been tabulated below, under the last named species.

*P. artemis* was first discovered by Mr. DRESCHER on the slope of the volcano Tangkoeban Prahoe, at an elevation of about 1500 m., hovering above a very small muddy pool, situated about half-way the bottom of a funnel-shaped ravine surrounded by dense forest. Although this pool usually contains stagnant water, it is well-aerated by heavy rainfall and a dense submerse growth of *Hydrilla verticillata*.

On October 26, at about 10 o'clock in the morning, we visited this beautiful spot together but fruitless searched for the species nor did we succeed in securing its larva, although the sun had just appeared above the mountain's rail illuminating its favourite haunt rather invitingly.

As follows from the many successive dates of its capture, *artemis* does not seem to be very common there.

Along the shore of the much larger and rather deep Telagawarna, an old crater-lake belonging to the Gedeh-complex, the very swift males were also observed, but the species was especially common along very small marshy puddles in the immediate vicinity of the hot sulphur springs of the Kawah Kamodjan, where its mating habits and the oviposition could be thoroughly studied. A complete account on its life-history and a description of the early stages of *artemis* will be given in a special paper dealing also with the biology of *sumbawana*, a species breeding in running waters but occasionally met with in company with the former. Both species are restricted to higher altitudes, at least so in Java.



Fig. 25. — *Procordulia artemis*, sp. n. ♀ Java. Terminal segments of abdomen, dorsal view.

### *Procordulia sumbawana* FOERSTER.

*Somatochlora sambawana* ♂ FOERSTER (*Ann. Soc. ent. Belg.*, 43, 1899, pp. 64-65). — Hab.: Soembawa.

*Procordulia karnyi* ♂♀ FRASER (*Treubia*, VIII, livr. 3-4, pp. 472-473). — Hab.: Java.

Dr. FRASER has very kindly lent me the type male of his *Procordulia karnyi* from G. Tengger in East Java, the female (allotype, as indicated by FRASER on the pin-label!) being present in the collection of the Buitenzorg Museum. Both specimens were taken by Mr. HANS DOCTERS VAN LEEUWEN on 8.XII.1920 and 14.I.1921 respectively, at an elevation of about 1200 m.



Quite recently FRASER informed to me in a letter dd. March 24th, that the second female (also indicated as allotype here!) from G. Tengger is in the British Museum and that it was compared some days earlier with a female of *sumbawana*. According to Dr. FRASER the specimen of *karnyi* differs from *sumbawana* in possessing more cross veins in the anterior part of the wing (*sumb.*  $\frac{5.8.8.5}{7.5.5.8}$ , *karnyi*  $\frac{6.8.9.6}{8.6.6.8}$ ). As however the number of nodal cross veins is extremely variable in this genus, the above noted difference is without any value <sup>1)</sup>.

As to the male of *karnyi*, FRASER described the superior anal appendages of it as follows: — "... as long as the two last abdominal segments taken together, curving gently downwards from base, which is thickened, followed by a slight constriction, again thickening and finally tapering to a point" (loc. cit., p. 473). But in his letter to me the author writes: — "... but the anal appendages having had their apices broken off I am unable to compare them. This accounts for my not figuring them". Hence we are misinformed about the structure of these organs and therefore the description of their shape should be neglected.

The species was also reported from Wai Lima, S. Sumatra, leg. Dr. KARNY, but according to Dr. FRASER (in litt.), this record was erroneously given as not referring to *Procordulia*. The types of *karnyi*, now before me, do not differ in any respect from a series of *sumbawana* collected in various parts of the island. As *sumbawana* was apparently unknown to the author the Tengger specimens were considered as representing a new species.

It has been firstly reported from Soembawa by FOERSTER, and afterwards Java and Celebes were given as a habitat. In addition, MARTIN in the Selysian monograph, adds the Lesser Soenda islands Flores and Lombok to its territory and in the Brussels Museum I was enabled to examine a series of males from East Java (including a specimen from G. Tengger taken by FRUHSTORFER!), Soemba and Celebes, so that we can safely say that it ranges at least from Java to Timor, and Celebes.

Within the range of its distribution the species is not quite uniform, especially not in the shape of the male anal appendages and therefore a closer examination of a large number of specimens from different localities is necessary, with respect to a definition of its geographical races, which, I am strongly of opinion can ultimately be distinguished. For the present it seems wise to refer all members of this "Formenkreis" to *sumbawana* FOERSTER. A provisional outline of a new arrangement has already been elaborated by the author.

The most striking differences between *P. artemis* and *sumbawana* may be given as follows: —

<sup>1)</sup> Four females of Javanese *sumbawana*, now before me, have the following indices:  $\frac{6.9.9.6}{9.5.6.8}$ ,  $\frac{6.10.9.6}{9.6.6.8}$ ,  $\frac{5.9.9.6}{7.6.6.7}$  and  $\frac{6.8.9.6}{8.5.6.7}$ , whereas the female in Mus. Buitenzorg has  $\frac{6.8.9.6}{7.5.6.8}$ , thus not markedly differing from the others!



*artemis*

Arculus in front wing situated at a level midway between first and second antenodal nervures or only slightly beyond.

Insect of smaller size and slender build.

♂ Superior anal apps. very slender, in profile view hardly thickened and without distinct nod at extreme base, very gradually narrowed to the end (fig. 24).

♀ Anal appendages about as long as segm. 9, very slender, gradually tapering from base to apex, tips almost pointed. In front wing below pterostigma no yellow area.

*sumbawana*

Arculus in front wing situated at a level much nearer the second than the first antenodal cross vein (from  $\frac{1}{3}$  to  $\frac{1}{8}$  of the length of the space).

Insect of comparatively large size and stouter build.

♂ Superior anal apps. more robust, in profile view much swollen and distinctly bent at base, then considerably narrowed and after their middle again much widened, rather club-shaped, finally more or less pointed.

♀ Anal appendages more robust, as long as segm. 9 + 10, after a slight constriction at base distinctly swollen and finally again somewhat narrowed, with rounded tips. In front wing below the pterostigma a large pale yellow or golden area.

## Fam. AESCHNIDAE.

## Subfam. AESCHNINAE.

*Gynacantha bayadera* SELYS-RIS.

*Gynacantha bayadera* (pars!) ♂♀ SELYS (*Ann. Mus. civ. Genova*, 30, 1891, p. 483). — Hab.: Sikkim.

*Gynacantha bayadera* ♂♀ RIS (*Ann. Soc. ent. Belg.*, 55, 1911, pp. 244-245). — Hab.: Java, Celebes, ? Darjeeling.

*Gynacantha bayadera* ♂♀ RIS (*Nova Guinea*, 13, livr. 2, 1915, pp. 111-112, fig. 35). — Hab.: Sikkim, Formosa, Banka, Java, Borneo, Celebes.

*Gynacantha millardi* (pars!) ♀ FRASER (*Treubia*, VIII, livr. 3-4, p. 479). — Hab.: Java.

Dr. RIS in a very clear exposition of the systematical difficulties occurred in consequence of the hopelessly confused synonymy of this species, comes to the conclusion that SELYS's name *bayadera* can be adjudged with almost the same justice to two different species, the original description very clearly pointing to the fact that SELYS had two different species before him at that time (RIS, l.c.



1915). Dr. RIS further proposes to keep the name *bayadera* for the species inhabiting Sikkim, Formosa, the Great Soenda Islands and those situated more eastward. I follow RIS in this respect because *bayadera* nob. is at present well-known among all odonatists working in malayan dragonflies. It was characterized by the same author in 1911 (loc. cit., pp. 244-245) and a full description with a figure of the male anal appendages were given in „Nova Guinea”.

The double of *bayadera* nob. (male and two females from Palone and Bhamò in Burma; Mus. Brussels) of which MARTIN gave a figure of the terminal appendages in his monograph, needs a comparison with a series of related species described afterwards. A future monographer should also bear in mind MARTIN's *G. saltatrix* of Tonkin.

The collection of the Buitenzorg Museum contains a female, taken near Buitenzorg, which was sent to Dr. FRASER for identification and was determined as *millardi* FRAS., a species from northern Peninsular India that according to its creator and to Dr. LAIDLAW is quite distinct. I have not seen any specimen of the true *millardi* but I am perfectly sure the female from Buitenzorg being identical with *bayadera* nob., of which I have examined good series from different localities in Java. It is a moderately common species in Java, more often found at higher elevations than in the coastal region. Specimens which I saw from Sumatra and S. Celebes are not different.

I can not judge whether *millardi* can be distinguished from *bayadera* nob. or not. If it is a distinct species the Javanese female was evidently wrongly identified.

### ***Gynacantha basiguttata* SELYS.**

*Gynacantha javica* ♀ FRASER (*Treubia*, VIII, livr. 3-4, pp. 479-480). — Hab.: Java.

Another large Aeschnine dragonfly taken in Buitenzorg, Java, and described by Dr. FRASER as a new species, has been recognized by me as an example of *G. basiguttata* SELYS, a rather rare species in Java and previously insufficiently known in the female sex. I am, however, perfectly sure that there can be no doubt about its identification as I have at my disposal a splendid series of this species, all taken by Mr. DRESCHER on various localities in western Java, among which are two pairs taken *in copula* on Noesa Kambangan, a small island on the south-coast. So I was fortunate enough to undertake a direct comparison leading to the above result. The specimen is adult and in good condition. To the ample description I have nothing to add. The light brown stripes in the anterior part of the wings, gradually passing into the rusty-brown spots at base, are present in all examined females and will serve to its recognition.

FRASER compares his specimen with *C. limbalis* KARSCH, a species of much larger size. Since the date of its description, about forty years ago, it has never been rediscovered.



**Platycantha dirupta** KARSCH.

*Gynacantha reticulata* ♂ FRASER (*Treubia*, VIII, livr. 3-4, 1926, pp. 478-479).

— Hab.: Kei.

*Platycantha dirupta* ♂♀ RIS (*Nova Guinea*, 9, livr. 3, 1913, p. 489 (key), 492-494, fig. 11 (anal apps. ♂), 12 (wings ♀)).

A recent examination of the type specimen of *Gynacantha reticulata* FRAS., a male from Kei Island, Gg. Daab, 14.IV.1922, no. 142, H. C. SIEBERS leg., present in the Buitenzorg Museum and labelled by Dr. FRASER., brought to light that this insect is a true *Platycantha* as could be concluded already from the original description, cited above.

The colours of this very mature specimen, especially those on the thorax, have much faded but otherwise it is in a perfect state of preservation. Other specimens of *dirupta* from S.W. New Guinea have been examined by the author in the Amsterdam Museum and were identified by Dr. RIS. The present male now before me, agrees so perfectly with RIS's description and his good figures of the very characteristic anal appendages, that there can be no doubt as to refer it to *dirupta* KARSCH, a species originally described from the same group of islands.

Apart from other venational characters, the genus *Platycantha* is readily distinguished from oriental *Gynacantha*'s by the two-celled anal triangle in the male sex, by the different shape of the head, etc.



# EINIGES ÜBER DIE BIOLOGIE OST-INDISCHER MANGROVEKRABBen.

Von

J. VERWEY.

(Laboratorium voor het Onderzoek der Zee, Batavia).

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## EINIGES ÜBER DIE BIOLOGIE OSTINDISCHER MANGROVE-KRABBen.

### EINLEITUNG.

Die Fauna der Mangrove, des Gebietes der sogenannten Flutwälder, bildet oekologisch ein nicht weniger charakteristisches ganzes als die Flora. Der Salzgehalt des Wassers und des Bodens, die damit zusammenhängende Einförmigkeit der Vegetation und des Schlammbodens, das stets wechselnde Spiel von Flut und Ebbe, die jeden Tag Futter bringen und zurücklassen, nicht zum mindesten die feuchtwarme Umgebung, diese zusammen bewirken das Zustandekommen einer Tierwelt, die mehr Interesse beanspruchen darf, als ihr bis jetzt zu Teil wurde.

Das Mangrovegebiet entsteht, wo Flüsse ins Meer ausströmen. Die Flüsse führen Schlamm an, der sich besonders da ablagert, wo die Schnelligkeit des Stromes geringer wird, wo das Land ins Meer taucht. Der feinste Schlamm wird ins Meer hineingeführt, der gröbere Schlamm bildet an der Küste einen Schlammboden, der während der Ebbe zum Teil trocken liegt, auf der Grenze zwischen dem Meer und dem Land legt die Mangrove dieses Land fest. Wo die Mangrove ausgedehnte Strecken einnimmt, fallen die Wälder von weitem auf. Als eine üppige dunkelgrüne Zone zeichnet sich die Küste jedem ab, der sich ihr über das Meer nähert. Man hat ein ausgedehntes Deltagebiet vor sich, in welchem die Gewässer, an Grösse abwechselnd von breiten Flüssen bis zu schmalen Gräben, sich verkriechen im Wald der Mangrovebäume, deren Stelzwurzeln dem Boden Festigkeit verleihen.

Die Tiefe des Mangrovegebietes, wenn man vom Meer aus in den Wald hineingeht, wird bestimmt durch die Stromstärke der betreffenden Flüsse und den Tidenhub. Wo die Flut bis zu zwei Meter über das Niveau der Ebbe reicht, ist die Zone breiter als da, wo der Unterschied nur einen Meter beträgt. Wo die Flüsse schnell strömen und dadurch das Meerwasser nicht eindringen lassen, setzt die Süßwasserflora sich fort bis dicht an das Meer (bei Batavia Moeara Angke).

Wo das Mangrovegebiet unberührt geblieben ist (das Holz ist sehr wertvoll) und seine ideale Zusammensetzung behalten hat, kann man mehr oder weniger deutlich einige Baumzonen unterscheiden, die ihre Entstehung dem verschiedenen Grad der Bodenfeuchtigkeit verdanken und für die also, wo sie an den Flüssen grenzen (nicht einwärts, wo die Abwässerung schlecht ist), eine gewisse Höhe über dem Meeresniveau typisch ist. Eine Zonenbildung unter Einfluss des Salzgehaltes (weit vom Meere im Mittel weniger salzig als nahe am Meere) scheint bei Batavia nur wenig ausgeprägt zu sein.

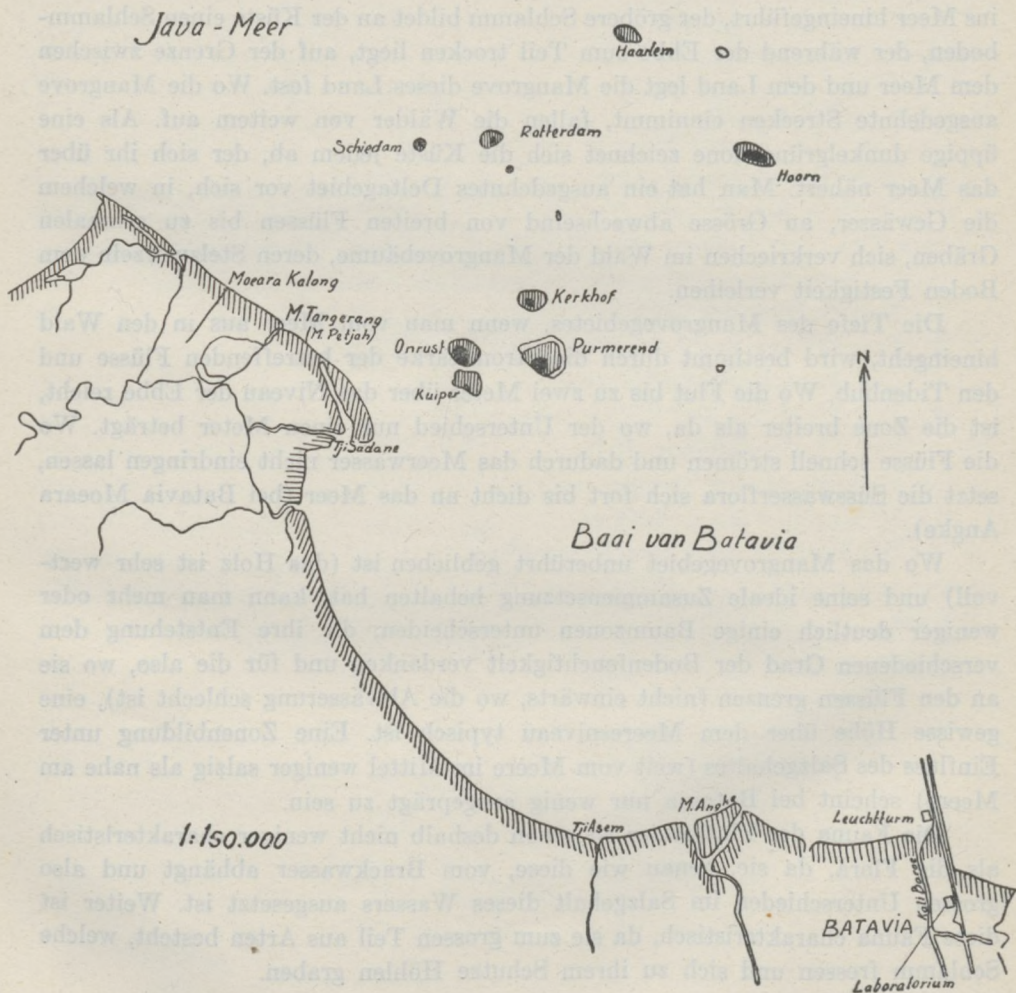
Die Fauna der Flutwälder ist schon deshalb nicht weniger charakteristisch als die Flora, da sie, genau wie diese, vom Brackwasser abhängt und also grossen Unterschieden im Salzgehalt dieses Wassers ausgesetzt ist. Weiter ist diese Fauna charakteristisch, da sie zum grossen Teil aus Arten besteht, welche Schlamm fressen und sich zu ihrem Schutze Höhlen graben.



Von dieser Fauna habe ich nur einige Krabbenarten auf ihre Biologie untersucht. Besonders die Winkerkrabben sind reizend und ich habe mich bemüht im zweiten Teil einige ihrer Lebensgewohnheiten, wie das Graben, das merkwürdige Winken und das Fressen für *Uca signatus* ausführlicher zu beschreiben. Dabei bin ich auf das anziehende Problem der Atmung amphibisch lebender Krabben näher eingegangen, als in einem solchen Beitrage vielleicht gerechtfertigt wäre; es schien mir aber verkehrt diese Notizen gesondert zu publizieren. — Man findet einige oekologischen Wahrnehmungen über Schnecken erwähnt, sie sind aber oberflächlich und betreffen nur die Zonenbildung.

### MATERIAL UND METHODE.

Die Untersuchungen fanden grösstenteils in der Nähe von Batavia statt, und zwar besonders im Deltagebiet der Tji Sedane gegenüber der Insel Onrust in der westlichen Hälfte der Bai von Batavia. Ganz besonders untersuchte ich hier die Moeara Petjah (oder M. Tangerang) und Moeara Kalong. Ich hatte





weiter kurz Gelegenheit auch die berühmte Mangrove bei Tjilatjap an der Südküste Javas, die viel ausgedehnter ist als die bei Batavia, kennenzulernen, und weiter sammelte und beobachtete ich einige Stunden lang in der Nähe von Soerabaja, Ost-Java. Ich erhielt weiter, durch die freundliche Mithilfe der Frau BRINK-VAN MULLEM, aus Piroe, West-Ceram, Winkerkrabben von dort lebend zugesandt, die ich einige Zeit im Laboratorium studierte.

Das Verlandungsgebiet bei Batavia ist ziemlich ausgedehnt; es umfasst mehrere Flussmündungen, von denen jede ihr eigenes Gepräge hat, was Fauna und Flora betrifft. Die Mangrovelandschaft an sich ist aber so typisch, dass es nicht schwer war, die Zonen, die ich an einer kleinen Stelle bei Batavia unterscheiden lernte, in anderen Mangrovegebieten wiederzufinden, nicht nur bei Batavia, sondern auch an der Südküste und in Ost-Java. Und es würde lohnend sein, zu untersuchen, in wieweit die weiter unten gegebene Unterscheidung sich an weiteren Stellen durchführen lässt.

Ausser im freien studierte ich die Tiere, speziell *Uca*, in der Gefangenschaft. Es ist anziehend, diese Tiere in der Gefangenschaft kennenzulernen und man ist anfangs erstaunt, wie leicht die meisten sich halten lassen. Ich richtete Terrarien aus Mangroveschlamm für sie ein, die auf der einen Seite fast ganz mit Schlamm, auf der andern Seite mit Brackwasser oder Meerwasser gefüllt waren. Dabei wählten die Tiere sich selbst den höher liegenden Schlamm oder den ganz nassen in der Nähe des Wassers. Dann und wann füllte ich das ganze Terrarium mit Wasser, das ich einen Tag stehen liess; bisweilen rührte ich ausserdem in diesem Wasser. Die ganz oberflächliche Schicht des Schlammes wurde in dieser Weise erneuert und nachdem ich das Wasser wieder abgesogen hatte, kamen die Tiere aus den Höhlen hervor und fanden den Tisch aufs neue gedeckt. Die Terrarien hatte ich unbedingt an der Sonne zu halten, da die Tiere sonst nicht zum Vorschein kamen und schliesslich in ihren Höhlen starben. Diese Krabben, für die die Tropennacht zu kühl ist, kommen oft erst einige Stunden nach Sonnenaufgang aus ihren Verstecken hervor und werden aktiv wenn ein Mensch die brennende Hitze der Mangrove kaum länger erträgt.

Einen Teil der Untersuchungen führte ich in einem Hilfslaboratorium auf der Insel Onrust aus, die in der Nähe der Mangrove liegt. Ich bin dafür Herrn und Frau STEINFURTH, dem Administrator und Arzt dieser Quarantaine-station, zu besonderem Dank verpflichtet.

Das Material wurde in Holland bestimmt. Die Crustaceen sandte ich Dr. J. G. DE MAN, Ierseke, der sich keine Mühe sparte, mir durch ausführliche Synonymangaben und das Kopieren von Beschreibungen zu helfen. Die Mollusken wurden von Fräulein W. S. S. VAN BENTHEM JUTTING, Zoologisches Museum der Universität Amsterdam, identifiziert. Eine schnellere Bearbeitung des Materials hätte niemand liefern können. Einige Fische wurden von Prof. Dr. L. F. DE BEAUFORT, einige Nacktschnecken von Dr. ENGEL, Zoologisches Museum, Amsterdam, untersucht; auch ihnen bin ich zu grossem Dank verpflichtet. Nach dem Tode von Dr. DE MAN wurden die übrigen Krabben von Dr. H. BALSS, München, identifiziert; auch ihm sei hier herzlichst gedankt.



Weiter habe ich Ir. B. MARKUS, dem Technologen unseres Laboratoriums, für seine Hilfe bei der Ausführung der ernährungsphysiologischen Versuche zu danken, und Dr. Ir. C. P. MOM, Direktor der Station für Wasserreinigung, für Hilfe und Ratschläge. Schliesslich Dr. BOSCHMA, Dr. UMBGROVE und Herrn WIJNHAMER für die Aufnahme der Photographien.

Was die Literatur anbelangt, so ist über die Lebensweise von *Uca*, der es hier speziell gilt, ziemlich viel gearbeitet worden. Besonders die Beiträge von PEARSE, von denen der erste, von 1912, der wertvollste ist, werde ich oft nennen. Sehr exakt sind die Beobachtungen, die HYMAN über die larvale Entwicklung publiziert hat. Was die Literatur über die Atmung amphibisch lebender Krabben anbelangt, so ist man erstaunt, wie wenig seit der Zeit MILNE-EDWARDS' und MÜLLERS darüber publiziert wurde. Die alten Beobachtungen MÜLLERS, die teilweise unrichtig sind, findet man fehlerlos bis in unsere neuesten Handbücher kopiert, ohne dass sie in den indessen vergangenen 70 Jahren wiederholt wurden.

Der erste Teil dieses Beitrags behandelt die Zonenbildung in der Mangrove, und zwar die der Brachyuren und Schnecken; der zweite Teil befasst sich mit der Biologie von *Uca signatus* (HESS), mit vergleichenden Bemerkungen über die Biologie anderer Krabbenarten.

## ERSTER TEIL.

### DIE ZONENBILDUNG IN DER MANGROVE.

#### A. DIE ZONENBILDUNG (Brachyura und Gastropoda).

Die oekologischen Bedingungen, die sich die hier zu behandelnden Arten suchen, kommen am deutlichsten in der Zonenbildung zum Ausdruck, der wir überall in der Mangrove mehr oder weniger deutlich begegnen.

Beschränkt man sich auf Krabben, so lassen sich bei Batavia die folgenden Zonen unterscheiden.

##### 1°. Die Zone von *Sesarma taeniolata* WHITE.

Sie ist die höchste und reicht vom Niveau der Springflut (bisweilen vielleicht noch etwas höher) bis wenig unter das Niveau des gewöhnlichen Hochwassers. Ausser von *taeniolata* wird diese Zone von *S. meinerti* DE MAN und von der Paguride *Coenobita cavipes* STIMPSON bewohnt.

##### 2°. Die Zone von *Uca consobrinus* (DE MAN).

Sie wird von dem obersten Teil der Schlammbänke, der noch regelmässig von dem gewöhnlichen Hochwasser erreicht wird, gebildet.

##### 3°. Die Zone von *Uca signatus* (HESS).

Diese Zone bildet bei Batavia für den gelegentlichen Besucher die Hauptzone. Sie reicht von wenig unter dem Niveau des Hochwassers bis dahin, wo der Schlamm ganz nass zu werden beginnt und umfasst also den Teil der Schlammbänke, der von mittlerer Härte ist. Ausser von *U. signatus* wird sie, offenbar besonders in ihrem oberen, an der 2. Zone grenzenden



Teil, von einer kleinen Krabbe bewohnt, die erst vor einigen Jahren beschrieben wurde: *Ilyoplax delsmanni* DE MAN.

4°. Die Zone von *Metaplex elegans* DE MAN.

Diese Zone lässt sich, wenn die Verhältnisse günstig sind, in zwei Subzonen teilen: a. Die Zone von *Metaplex elegans sensu stricto*,

b. „ „ „ *Paracleistostoma depressum* DE MAN.

Diese vierte Zone fängt an, wo man in den Schlamm einzusinken beginnt und sie setzt sich nach unten bis zum Niveau der niedrigen Ebbe fort. In ihrem oberen, etwas mehr konsistenten Teil bevölkert *Metaplex* den Schlamm zu Hunderten, in ihrem niederen, „schlammigeren“, ganz feuchten Teil ist *Paracleistostoma* Leittier.

Es wird diese Zone ausserdem von einigen *Sesarma*-arten bewohnt, von denen besonders die erste äusserst allgemein sein kann: *Sesarma bataviana* DE MAN und *Sesarma cumolpe* DE MAN. Weiter kommt bei Batavia als Seltenheit vor: *Uca urvillei* H. M.-EDWARDS.

5°. Die Zone von *Scylla serrata* (FORSKAL).

*Scylla serrata*, die in Indien überall bekannte Kepiting, bewohnt den Schlamm, der unter oder wenig über dem Niveau niedriger Ebbe liegt.

Das ganze Gebiet, das die Zonen 1-5 umfasst, wird weiter von einem Thalassiniden bewohnt, dessen Biologie wir ebenso ausführlicher behandeln werden: *Thalassina anomala* HERBST. Wir werden weiter unten sehen, weshalb diese Art so allgemein verbreitet ist. Ausserdem gibt es eine Krabbenart, die eine grosse Verbreitung in der Mangrove zu besitzen scheint, die aber offenbar eine nächtliche Lebensweise hat, weshalb man ihr fast nur beim Ausgraben begegnet: *Macrophthalmus definitus* WHITE. Und schliesslich will ich, da sie für uns Interesse hat, noch nennen *Tachypleus gigas* (MÜLLER) (= *Limulus moluccanus* LATR.).

Es ergibt sich also, wenn man einen idealen Durchschnitt durch den Rand einer Schlammbank herstellt, nebenstehendes Bild (Fig. 1).

Die Figur wird besser verständlich, wenn wir weiter unten die Biologie der Tiere ein wenig kennen lernen werden. Der Tidenhub bei Batavia (man sehe die Gezeitentafel auf Seite 181) beträgt 0.2 m - 1.10 m, in der Mangrove also etwas mehr. Der vertikale Höhenunterschied zwischen Zone 1 und 5 beträgt also maximal ungefähr 1.20 m. Es sei aber gleich hinzugefügt, dass dies nur für den Rand der Schlammböden gilt. Die Mitte der Böden ist immer niedriger als der Rand und durch die schlechte Abwässerung hat man da ein ganz feuchtes Gebiet, mit zusammengeschobenen Zonen, von denen besonders die unteren viel höher als die ihnen entsprechenden an der Aussenseite der Böden liegen. Es ist meistens sehr schwer auf diesem Innenteil der Böden überhaupt etwas von Zonen zu erkennen.

Es versteht sich, dass die fünf genannten Zonen auch von anderen Tieren und nicht nur von Krabben charakterisiert werden. Der Schlamm dient naturgemäss auch anderen Tieren zum Futter und da die Zeit des Trockenliegens den Charakter des Schlammes ändert, ändert sie ebenso die Futterverhältnisse und beeinflusst sie damit die lebende Welt.



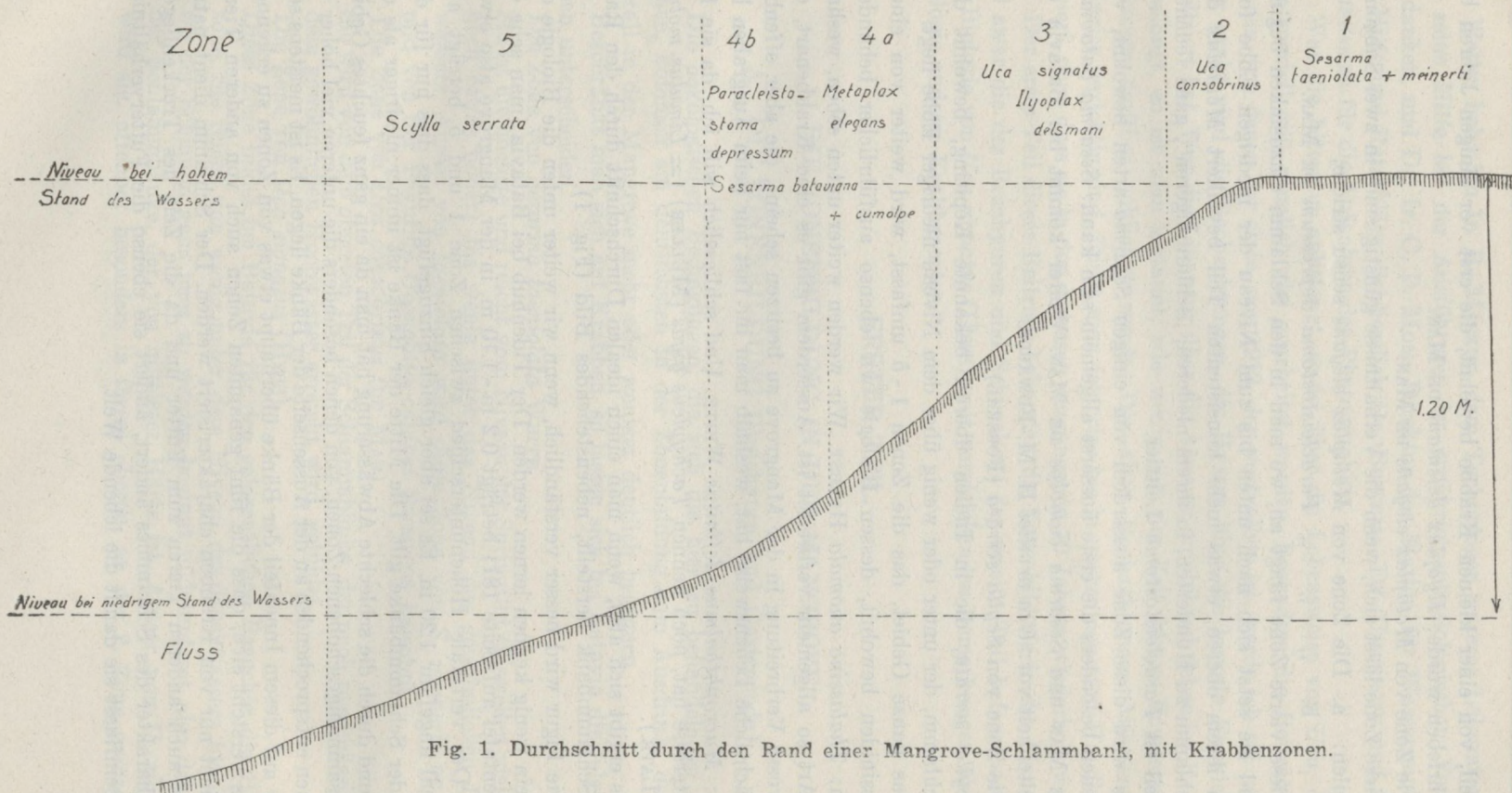


Fig. 1. Durchschnitt durch den Rand einer Mangrove-Schlammbank, mit Krabbenzonen.



Von den anderen Tieren habe ich nur versucht die Schnecken in die Zonen-unterscheidung unterzubringen und zwar mit dem folgenden Ergebnis. Von den Schnecken sind für das hier behandelte Gebiet die folgenden Arten mehr oder weniger charakteristisch: *Cassidula auris-felis* BRUG., *C. mustelina* DESH., *C. cumingiana* RECLUZ, *Cerithidea obtusa* LAM., *C. quadrata* SOW., *C. alata* PHIL., *Telescopium telescopium* (L.), *Littorina intermedia* PHIL., *L. melanostoma* GRAY, *L. carinifera* MENKE, *L. scabra* L., *Pythia plicata* FER., *Terebralia sulcata* BORN, *Salinator burmana* BLANFORD, *Auricula auris judae* L., *Assimineea brevicula* PFR., *Haminea* sp.

Von diesen Arten fand ich einige bloss dicht am Meere und diese kommen also weiter für uns nicht in Betracht: *Pythia plicata* FER., *Littorina intermedia* PHIL. und *Littorina melanostoma* GRAY.

Von den übrigen Arten sind einige ausschliesslich Bewohner der trockenen Bänke, andere bewohnen nur die niedrigen Stellen. Die trockenen Bänke werden bewohnt von *Cassidula auris-felis*, *C. mustelina*, *Cerithidea quadrata* und *obtusa*, *Littorina carinifera* und *scabra*. Vielleicht gehören hierher auch *Cassidula cumingiana* und *Auricula auris judae*, von denen ich nur 2, resp. 1 Tier fand.

Die niedrig liegenden Bänke werden bewohnt von: *Assimineea brevicula*, *Terebralia sulcata*, *Cerithidea alata*, *Telescopium telescopium*, *Salinator burmana* und *Haminea*.

Wenn man jetzt auch für diese Tiere die Zonenbildung studieren will, so muss man bedenken dass viele von ihnen keinen Schlamm fressen. Das ist der Grund, weshalb man unter den Arten der trockenen Bänke gar keiner Zonenbildung begegnet. Sie kommen überall vor, wo der Boden bewachsen und nicht zu nass ist und bevölkern also die Zonen 1, 2 und 3 der Krabben, wenn es da Holz gibt. Unter den Arten der nassen Bänke begegnet man aber einer deutlichen Zonenbildung, da diese Arten wiederum Schlamm fressen. Sie halten, von oben nach unten gerechnet, die Reihenfolge ein:

*Assimineea*, *Terebralia*.

*Salinator*, *Haminea*.

*Telescopium*, *Cerithidea*.

Wenn wir jetzt noch einmal die Zonen mit den ihnen zugehörenden Krabben und Schnecken zusammenstellen, so erhalten wir:

Zone I. *Sesarma taeniolata* und *S. meinerti*. Wo die Zone bewachsen ist: *Coenobita cavipes*, *Cassidula auris-felis* und *mustelina*, *Cerithidea quadrata* und *obtusa*, *Littorina carinifera* und *scabra*.

Zone II. *Uca consobrinus*.

Wo bewachsen *Coenobita cavipes* und die gleichen Schnecken wie in der ersten Zone.

Zone IIIa. *Uca signatus*, *Ilyoplax delsmanni*. Wo die Zone bewachsen ist und der Schlamm konsistenter, also besonders im oberen Teil dieser Zone, die gleichen *Coenobita* und Schnecken wie in der ersten Zone.

b. In der unteren Hälfte der *signatus*-zone zahlreich *Assimineea brevicula*. Hier und in der vierten Zone *Uca urvillei*.



Zone IVa. *Metaplex elegans*. Oben noch *Assiminea*.

b. *Paracleistostoma depressum*. Es finden sich in dieser Zone weiter *Sesarma bataviana* und *Sesarma cumolpe* und an Schnecken finden sich *Salinator burmana* und *Haminea spec.*, weiter *Cerithidea alata* und *Telescopium*.

Zone V. *Scylla serrata*, *Cerithidea alata*, *Telescopium*.

Wir wollen jetzt noch kurz die Verhältnisse bei Batavia mit denen an anderen Stellen vergleichen <sup>1)</sup>).

Die Bedingungen, die wir auf den höher und niedriger liegenden Teilen einer bestimmten Schlammbank antreffen, sind, was das Klima und die Beschaffenheit des Bodens anbelangt, ganz dieselben. Wenn wir also auf einer einzigen Bank ganz verschiedene Tiere antreffen, je nachdem wir niedriger oder höher arbeiten, da dürfen wir ruhig annehmen, dass hier wirklich nur ein Faktor ausschlaggebend ist: die Höhe über dem Meeresniveau. Dieser Faktor könnte die Zonenbildung aus zweierlei Gründen beeinflussen: erstens könnte es sein, dass die verschiedene Dauer der Überschwemmung, zweitens dass der damit zusammenhängende Feuchtigkeitsgrad des Bodens eine Rolle spielt. Soweit ich feststellen konnte, spielt die Dauer der Überströmung an sich bei der Zonenbildung keine Rolle, obgleich wir gewiss erwarten dürfen, dass sie die Lebensweise der Tiere weitgehend beeinflusst. Der Feuchtigkeitsgrad des Bodens aber spielt deswegen eine grosse Rolle, da er für die Nahrungsverhältnisse ausschlaggebend ist.

<sup>1)</sup> HARMS, in seinem Beitrag über die Landtierwerdung, unterscheidet bei Batavia auch Zonen, und zwar deren fünf, wenn er von der Mangrove aus ins Meer hineinläuft. Er betrieb seine Studien aus anderem Gesichtswinkel, dennoch sind viele seiner Angaben für uns von grossem Interesse. Nur ist es schade, dass dieser Beitrag, der schöne und unwichtige Befunde in buntem Wechsel durch einander bietet, mehrere kleine Ungenauigkeiten enthält, die der Autor hätte vermeiden können. Einige Beispiele mögen genügen.

Der Salzgehalt der Zonen III-V wird als 34% angegeben (p. 234), es wird aber nicht darauf geachtet, dass er Schwankungen unterworfen ist. — Die Sauerstoffbestimmungen — wie sie (p. 239) gegeben werden — sind wertlos. HARMS bemerkt zu ihnen: „Die grosse Differenz zwischen den beiden (Doppel-) Bestimmungen kann ich mir nicht erklären“. Er fügt aber hinzu: „Wasser Nr. 3 war stark trübe“. Es ist ja bekannt, dass WINKLERSche Sauerstoffbestimmungen trüben Wassers unbrauchbares Resultat ergeben. Auf S. 241 werden diese Sauerstoffbestimmungen aber benutzt zur Charakterisierung der verschiedenen Zonen. „Bemerkenswert sind die starken Verschiedenheiten im O<sub>2</sub>-Gehalt“ (hier Verschiedenheiten der Zonen, während aber die Kontrollbestimmungen einer Zone für sich die Befunde wertlos machen). — Der Unterschied zwischen Höchst- und Tiefststand des Wassers wird (p. 235) als etwas über 1 m angegeben, eine Angabe die der Tabelle der Arbeit SUNIERS entnommen wird. Diese Tabelle gibt aber als Maximumunterschied 1.10, als Minimumunterschied 0.20, als Mittel 0.6 - 0.7 m an. — Die Angaben „rote Krabbe“, „grüner Seestern“, u.s.w. hätten in einem wissenschaftlichen Beitrag besser vermieden werden können. Die roten Krabben werden auf S. 225, 238, 242, 247 und 304 genannt. Sie werden auch grosse Ocypoden, Mangrovekrabben, rote Landkrabbe, rote Strandkrabbe und unscheinbar gefärbte Krabben genannt, zu den Ocypoden gerechnet und einige Male *Ocypoda macrocera* genannt. Nach HARMS leben sie, ausser in Höhlen mit runden Öffnungen, auch in solchen mit hohem kegelförmigen Aufbau. Aus den Angaben geht aber deutlich hervor, dass mit dieser Krabbe *Sesarma taeniolata* (WHITE) gemeint wird, die zu den Grapsiden gehört. Die Höhlen mit kegelförmigem Aufbau werden nicht von dieser Art, sondern von *Thalassina anomala* gemacht; bisweilen gräbt *Sesarma taeniolata* in diese Hügel ihre Gänge, wodurch HARMS' Angabe sich erklären lässt.

Aus vielen weiteren Angaben geht hervor, dass dieser Beitrag mit der nötigen Vorsicht benutzt werden muss.



Unabhängig von dem Feuchtigkeitsgehalt des Schlammbodens wirkt natürlich auch die oben schon genannte Beschaffenheit des Schlammes. Sie ist fast ganz oder ganz ohne Einfluss, wenn man eine einzige Bank untersucht, übt aber grossen Einfluss auf die Zusammensetzung der Fauna (wie der Flora), sobald wir Bänke aus grösserer oder kleinerer Entfernung mit einander vergleichen. Natürlich müssen wir dabei innerhalb des Verbreitungsgebietes der betreffenden Arten bleiben, denn sobald eine Art durch eine andere ersetzt wird, hat eine Vergleichung der Fauna in diesem Zusammenhang keinen Sinn mehr. — Vergleich der Bänke, welche nur wenig von einander entfernt liegen, machen wir täglich, wenn wir ein bestimmtes Gebiet untersuchen. Hier findet man *Ilyoplax delsmanni*, die fast nirgends zahlreich auftritt, zu Hunderten, da findet man *Uca urvillei*, die sonst fast überall fehlt. Während *Cassidula auris-felis* stets viel zahlreicher als *C. mustelina* ist, findet man eine einzige Bank, auf der man auf kleinem Raum 38 *mustelina* gegen 13 *auris-felis* sammelt. Man versucht meistens vergebens den Grund für das Auftreten dieser Unterschiede zu begreifen. Nur wo die Verhältnisse ganz einfach liegen, ist dieser augensichtlich: so zum Beispiel die Reihenfolge *Ocypode ceratophthalma*, *Dotilla wichmanni*, *Uca consobrinus*, wenn die Bodenbeschaffenheit von sandig stets schlammiger wird. Weitere Beispiele für *Uca*-arten gab ORTMANN in BRONN (p. 1202). — Die Vergleichung weit von einander entfernter Gebiete ist nicht weniger interessant. Bei Soetji, in der Nähe von Soerabaja, Ost-Java, fand ich von oben nach unten: *Ilyoplax delsmanni*, ganz oben, wo sie nur eine ganz schmale Strecke bewohnte; *Uca marionis* DESM. in sehr grosser Zahl, dazwischen einige Exemplare von *Uca urvillei*; auf dem ganz feuchten Schlamm, unten, *Macrophthalmus erato* DE MAN.

Bei Tjilatjap, Südküste Mittel-Javas, fand ich, von oben nach unten:

*Uca consobrinus*,

*Uca species* } *Assimineae brevicula*,  
*Uca signatus* }

*Metaplex elegans*, und 3 andere *Uca*-arten, unter denen *U. urvillei* und *U. marionis*.

Zur Übersichtlichkeit stelle ich die Tiere noch einmal neben einander (siehe Tabelle Seite 178).

Diese Tabelle ist sehr lehrreich. Erstens zeigt sie deutlich, wie wir in Tjilatjap und Soetji genau die gleiche Stufenfolge der Arten wie in Batavia haben, dass also die Zonenunterscheidung von Batavia auch für Tjilatjap und Soetji gilt. Zweitens aber sehen wir, dass *Uca marionis*, die zahlreichste Art in Soetji, bei Tjilatjap selten ist (jedenfalls auf den wenigen von mir untersuchten Bänken) und in Batavia fehlt, dass umgekehrt *Metaplex elegans*, die in Batavia und Tjilatjap äusserst zahlreich vorkommt, in Soetji fehlt. Die soeben genannten Arten haben eine grosse Verbreitung und für das Fehlen oder Vorhandensein an einer bestimmten Stelle können zweifellos nur zwei Faktoren verantwortlich gemacht werden: erstens das Fehlen oder Vorhandensein der von den betreffenden Arten gesuchten Verhältnisse (grössere oder geringere Sandigkeit des Bodens, Quantität und Qualität des organischen Abfalls, u.s.w.), zweitens die isolierte Lage oder



die geringe Grösse des untersuchten Gebietes, wenn das Verbreitungsgebiet als ganzes betrachtet wird. Es scheint mir, dass für die von mir untersuchten Gebiete der letzte Faktor übersehen werden kann. Zweifellos ist der Hauptgrund für das

Batavia (Nordküste West-Javas)	Tjilatjap (Südküste Mittel-Javas)	Soetji (Ost-Java)
I. <i>Sesarma taeniolata</i>		
II. <i>Uca consobrinus</i>	<i>Uca consobrinus</i>	
III. <i>Uca signatus</i> <i>Ilyoplax delsmanni</i> <i>Assiminea brevicula</i>	<i>Uca signatus</i> <i>Uca species</i> <i>Assiminea brevicula</i>	<i>Ilyoplax delsmanni</i>
IV. <i>Metaplax elegans</i> <i>Uca urvillei</i>  <i>Paracleistostoma depressum</i>	<i>Metaplax elegans</i> <i>Uca urvillei</i> <i>Uca marionis</i> <i>Uca species</i>	<i>Uca urvillei</i> <i>Uca marionis</i> <i>Uca annulipes</i> <i>Macrophthalmus erato</i>

Fehlen von einer der genannten Arten im Fehlen der gesuchten Verhältnisse zu finden.

Hinzugefügt sei noch, dass die Zonenbildung der *Uca*-arten auch von PEARSE (1912, p. 115, und 1914, p. 416) beschrieben wurde. Er schreibt folgendes: "In the Philippines this specificity of habitat gives rise to fiddler zones along the populous margins of the esteros (estuaries): (1) High along the edge of the shore *Uca forcipata* is found; (2) this zone grades into one of *U. rathbunae* just below, and is followed by (3) another in the softer mud of the deeper parts of the estero, peopled by *U. marionis* and *U. marionis nitida*". "The less abundant *U. annulipes* and *U. gimardi* were usually found in the second and third zones respectively". Aus diesen Angaben liesse sich vielleicht schliessen, dass diese Zonen von PEARSE mit den Zonen II-IV dieses Beitrags übereinstimmen.

Was die Zonenbildung mit einander verwandter Schnecken anbelangt, die ist ebensowenig neu; so ist sie zum Beispiel bekannt für das Genus *Littorina* in Europa. "High on the beach live the viviparous *L. neritoides* LAMARCK and *L. rudis* (Donovan); intermediate is *L. obtusata* LINNAEUS which produces eggs that soon hatch out second-stage veligers; and near low-tide mark lives *L. litorea* LINNAEUS which lays encapsuled eggs that hatch out early veligers" (nach PEARSE, 1929).

Bevor wir jetzt zu einer näheren Besprechung der Zonen übergehen, wollen wir einige allgemeine Bemerkungen über die Lebensweise der Mangrovetiere voranschicken.

Zu allererst brauche ich wohl nicht darauf hinzuweisen, wie herrlich auch wieder bei dieser ökologischen Tiergruppe die Beziehungen zwischen der Or-



ganisation der Bewohner und den Eigenartigkeiten des Milieus sind. Erstens haben wir Brackwassertiere vor uns, die, wie fast stets, fortwährend grossen Änderungen im Salzgehalt des Wassers ausgesetzt sind. Mehr nach hinten in der Mangrove kann das Wasser bei Ebbe fast süss sein, während es bei Hochwasser salzig ist. Tiere, die sich dem plötzlichen Übergang entziehen können, wie die Fische, gehen, obgleich sie nicht einmal ihren osmotischen Druck nennenswert ändern, mit dem steigenden und fallenden Wasser auf und nieder. Wir wissen durch die Untersuchungen von BULL, dass *Blennius* schon reagiert auf eine Zunahme des Salzgehaltes von 0.3 %. Tiere aber, wie Krabben und Schnecken, sind diesen Übergängen fortwährend ausgesetzt und sie müssen also die Möglichkeit besitzen, ihren osmotischen Druck in kürzester Zeit entsprechend zu ändern; sie müssen im Stande sein, osmotische Druckunterschiede von 20 Atmosphären und mehr in kurzer Zeitdauer auszugleichen. Es würde lohnend sein, zu untersuchen, weshalb dies den Brackwassertieren leichter als den reinen Meerestieren gelingt. Einem Beitrag von YAZAKI (1929) entnehme ich, dass ein solcher Druck wohl zum allergrössten Teil auf Rechnung von NaCl zu setzen ist (*Ostrea circumpecta*: 93 - 94 %) <sup>1)</sup>. — Zweitens sind viele Mangrovetiere Schlammfresser und wenn sie keinen Schlamm fressen, wie einige Schnecken und Krabben, so verbringen sie ihr Leben doch auf oder in dem Schlamm und müssen darauf eingerichtet sein, vom Schlamm nicht gehindert zu werden. — Drittens leben viele der Tiere amphibisch. Ich sagte schon, dass die Bänke bei Hochwasser mehr oder weniger völlig überschwemmt werden können. Das hat zur Folge, dass die Tiere, die physiologisch mehr Land- als Wassertiere sind, dem Wasser entfliehen, dass aber die Tiere, die mehr Wasser- als Landtiere sind, sich in ihre Höhlen verkriechen. Es ist nun ganz interessant, zu sehen, wie die Verteilung der Mangrovetiere über diese zwei Gruppen, die der Luft- und die der Wasseratmer, zu Stande kommt. Sie ist nämlich nicht, wie man erwarten würde, eine Verteilung nach Gattungen, sondern es gibt unter den Arten einer einzigen Gattung Luft- und Wasseratmer. Und zwar ist die Verteilung so, dass alle Arten der niedrigen Bänke sich, wenn das Wasser kommt, überströmen lassen, dass alle Arten der hohen Bänke dem Wasser entfliehen. Wir werden das für Krabben weiter unten noch ausführlicher behandeln, aber schon jetzt möchte ich in diesem Zusammenhang die Hauptsache nennen.

<sup>1)</sup> SCHLIEPER hat in einem rezenten Beitrage, den ich erst zu Gesicht bekam, nachdem mein Beitrag fertig war, diese Frage für eine Brackwasserkrabbe, die Chinesische Wollhandkrabbe, *Eriocheir sinensis*, teilweise gelöst. Er findet, dass die Gefrierpunkts-erniedrigung des Blutes, bestimmt an Tieren, die einige Zeit im Meerwasser gehalten wurden, 1.66 - 1.82°C. beträgt, während die des benutzten Wassers von gleicher Grösse ist (1.72° - 1.82° C.). Im Süsswasser dagegen beträgt die Erniedrigung 1.22° - 1.25°C (für *Astacus* 0.80°C.). Während nun aber eine Meerkrabbe (*Hyas*), wenn sie in Süsswasser gebracht wird, osmotisch Wasser aufnimmt und dadurch an Gewicht zunimmt und meistens stirbt, tritt bei *Eriocheir* keine oder nur eine geringe oder vorübergehende Gewichtszunahme auf. SCHLIEPER zeigt, dass die Gewichtszunahme nicht ausbleibt, wenn er die Öffnungen der Antennendrüsen abschliesst; die Antennendrüsen scheiden also das Wasser aus. Die Brackwasserkrabbe *Eriocheir* löst das Problem also dadurch, dass sie, ausser dass sie ihre molare Konzentration ändert, mittels der Antennendrüse den Wasserhaushalt reguliert, wie dies beim Frosch von den Nieren besorgt wird.



Dem Wasser entfliehen nach unten <sup>1)</sup>: die *Uca*-arten, *Ilyoplax delsmanni*, *Metaplax* und *Paracleistostoma*, *Sesarma bataviana* und *S. cumolpe*, *Scylla* (die ja immer im Wasser lebt), *Thalassina*; von den Schnecken: *Assimineae*, *Terebralia*, *Cerithidea alata*, *Telescopium*, *Salinator burmana* und *Haminea spec.*

Dem Wasser entfliehen nach oben: *Sesarma taeniolata* und *S. meinerti*, sowie *Coenobita cavipes*, von den Schnecken: *Cassidula auris-felis*, *C. mustelina*, *C. cumingiana*, *Cerithidea quadrata* und *obtusa*, *Littorina carinifera* und *scabra*.

Wir sehen also, dass *Sesarma taeniolata* und *meinerti* dem Wasser entfliehen, *S. bataviana* und *cumolpe* darin untertauchen, *Cerithidea quadrata* und *obtusa* ihm entfliehen, während *C. alata* unten bleibt. Ein ähnliches Beispiel gaben HARMS und EGGERT für das Genus *Periophthalmus*: während die anderen Arten sich bei der Verfolgung ins Wasser hinein flüchten, flüchtet *argenteolineatus* sich aufs Land. Weitere Beispiele bieten unter den Fischen die Gobiiden und Blenniiden, unter den Paguriden die Coenobitiden; in wie weit hier die Luft- und Wasseratmer zusammen auf demselben Gebiet vorkommen, weiss ich nicht. HARMS gibt sogar für *Uca*-arten an, dass sie beim Steigen des Wassers diesem entfliehen. „Bei Tjilatjap beobachtete ich, dass bei eintretender Flut die *Uca*-Arten sich zu Tausenden in Herden vor dem Wasser flüchteten“.

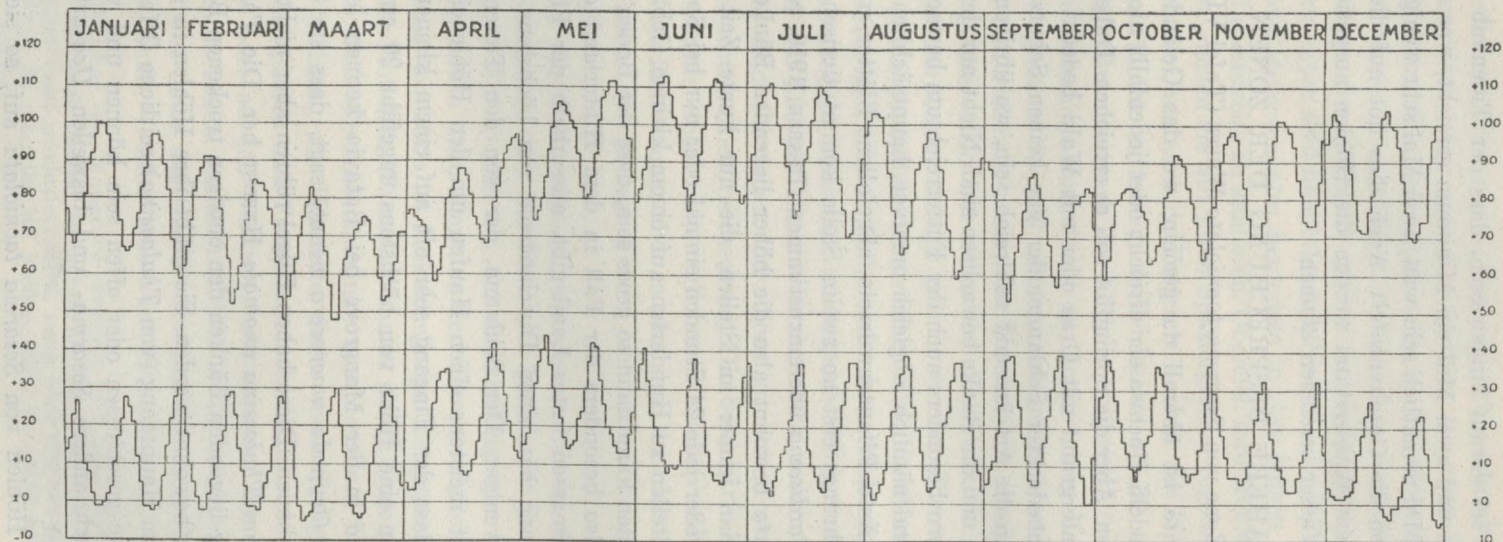
Es ist deutlich dass die verschiedenen Arten so ihrer Umgebung angepasst sind, dass sie physiologisch ganz verschiedene Typen repräsentieren in Bezug auf ihre Atmung. Es muss also ganz interessant sein, zu untersuchen, ob und, wenn ja, in was sich die Atmung der „Lungenatmer“ von der der mit ihnen verwandten „Kiemenatmer“ unterscheidet. Ich teile einige Beobachtungen, die ich darüber anstellte, im zweiten Teil mit.

Es fragt sich zuletzt, was die Tiere, die physiologisch Wasseratmer sind, dazu bringt, sich in ihre Höhlen zurückzuziehen, wenn das Wasser kommt. Am wahrscheinlichsten scheint mir, dass sie dadurch den Feinden entweichen, die mit dem Wasser heraufkommen. Besonders das Schliessen der Höhlen durch die *Uca*-arten, das wir später kennen lernen werden, scheint mir darauf hinzuweisen, dass die Tiere Schutz suchen. Näheres hierüber findet man im zweiten Teil.

Ausser ihrem Charakter als Mangrovetiere zeigen die hier behandelten Organismen noch eine weitere Merkwürdigkeit, die in der täglichen Lebensweise zum Ausdruck kommt. An der Nordküste Javas gibt es nur einmal pro Etmaal Ebbe und Flut. Diese fallen bei Batavia im allgemeinen im Laufe des Jahres jeden folgenden Tag etwas früher als den vorigen, mit dem Verstande, dass es in diesen meinen Beobachtungsjahren von ungefähr März bis September am Tage, von Oktober bis Februar während der Nacht Ebbe ist. Viele Nacht- oder Dämmerungstiere, wie die *Sesarma*- und *Metaplax*-arten, haben nun in der Zeit der Nachtflut keine Gelegenheit auf Futtersuche zu gehen und werden am Tage aktiv, die Tagtiere werden in der Zeit der Tagflut gezwungen, ihre normale Lebensweise zu ändern. Beispiele gebe ich weiter unten.

<sup>1)</sup> Wenn ich sage: die Tiere entfliehen dem Wasser nach unten, so bedeutet das für Krabben, dass sie ihre Höhlen aufsuchen, für Schnecken, dass sie sich in ihre Häuser zusammenziehen und liegen bleiben bis das Wasser fällt. Die Tiere, die dem Wasser nach oben entfliehen, klettern auf die Bäume.





Gezeitentafel für Tandjong Priok (Hafen von Batavia) 1929. Oben: Hochwasserstände; unten: der Stand niedrigen Wassers.



Zu gleicher Zeit sei darauf hingewiesen, dass der Tidenhub zwei Mal pro Monat ein Maximum und zwei Mal ein Minimum erreicht, was zur Folge hat, dass die Bänke zwei Mal monatlich sehr weit, zwei Mal sehr wenig weit trockenfallen (man sehe dazu die Gezeitentafel). Auch dies übt auf die Tiere seinen Einfluss; bei niedrigem Wasserstand werden die Höhlen ausgetieft, damit die Tiere dennoch das Wasser erreichen können.

## B. NÄHERE BESPRECHUNG DER ZONEN.

### I. Die Zone von *Sesarma taeniolata* WHITE (Tafel VI).

*Sesarma taeniolata* ist überall da gemein, wo das Gelände hoch genug liegt, um nicht von jedem Hochwasser erreicht oder jedenfalls nicht für längere Zeit erreicht zu werden. Aber die Springflut soll es erreichen. Dabei tut es nichts zur Sache, ob der Untergrund mit Gras oder mit Wald bedeckt ist. Im allgemeinen wird aber unbedeckter Schlamm, der gar keinen Schutz gewährt, gemieden; dagegen kann die Art äusserst zahlreich sein, wo übrigens die gleichen Verhältnisse bestehen und die Bänke bewachsen sind. Nicht nur der Schutz spielt hier eine Rolle, sondern besonders auch der Futterreichtum bewachsener Plätze. Die *Sesarma*-arten sind nämlich, obgleich omnivor, hauptsächlich Pflanzenfresser: halb vermoderte Äste, Pflanzenwurzeln, abgefallene Blätter, u.s.w. bilden an erster Stelle ihre Nahrung; erst an zweite Stelle kommt tierisches Futter. Sie scheinen hierin mit *Cardisoma* übereinzustimmen (PEARSE, 1916, p. 553).

*Sesarma taeniolata* bewohnt also die höher liegenden Bänke. Das heisst: die Höhlen findet man immer an Stellen, die nur kurze Zeit vom Wasser erreicht werden, entweder jede 24 Stunden einmal oder nur bei Springfluten. Sie liegen an günstigen Stellen zu Hunderten auf einem kleinen Gebiet beisammen und die Zahl der Höhlen kann dann so gross sein, dass der Boden durchhlöchert erscheint. Dies ist also besonders der Fall in dem Hinterland der Mangrove und da wo es einigermaßen festes Land gibt, ausserhalb der Flussdeltas.

Der Höhleneingang hat einen Durchmesser von höchstens 3-8 cm, für jüngere Tiere aber weniger. Der Schlamm, der von den Tieren nach aussen befördert wird, bildet meistens einen Haufen um den Höhleneingang herum, was zur Folge hat, dass der Eingang sehr oft auf einem kleinen Hügel liegt. Diese Hügel erreichen eine Höhe von höchstens ungefähr 20 cm. HARMS, der diese Krabben ebenso in der Mangrove bei Batavia kennen lernte und der sie irrtümlicherweise *Ocypoda macrocera* nennt, sagt, dass sie Schlammhügel von ziemlicher Höhe bauen. Diese hohen Hügel rühren aber nicht von *Sesarma taeniolata*, sondern von *Thalassina anomala* HERBST her. Die *Thalassina*-hügel bilden auf den niedrig liegenden Bänken den einzigen trockenen Boden, weshalb sie von *Sesarma* gern bewohnt werden. Sie gräbt ihre Höhlen in sie hinein und man findet, ausser dem Hauptgang (von *Thalassina*) seitliche Öffnungen, welche gegen die Hauptgänge geschlossen oder offen sein können und von *taeniolata* bewohnt werden. Auch andere *Sesarma*- und bisweilen *Uca*-arten bevölkern diese *Thalassina*-hügel.

Hackt man die Höhlen von *Sesarma taeniolata* auf, so sieht man, dass



sie sich mehr oder weniger schief oder ziemlich senkrecht nach unten bis in das Grundwasser fortsetzen, also bis dorthin, wo noch bei niedrigem Wasserstand Wasser steht. Sie sind bei Batavia, wo der Höhenunterschied zwischen Ebbe und Flut maximal ungefähr 1.— bis 1.2 m beträgt, bis zu 1.5 m tief, müssen aber da, wo der Tidenhub grösser ist, tiefer sein.

Die *Sesarma*-arten sind hauptsächlich Nacht- oder jedenfalls Dämmerungstiere. Man findet draussen also besonders in den frühen Morgenstunden Gelegenheit, ihre Lebensweise zu studieren. Obgleich ihre Höhlen nur auf trockenem Schlamm liegen, suchen sie auf ihren Spaziergängen regelmässig den niedrigliegenden Schlamm auf, um auch da Futter zu suchen. Sie können sich dabei sehr weit von ihren Höhlen entfernen, vielleicht bis zu 30 m und mehr. Dabei sind sie begreiflicherweise stark der Gefahr ausgesetzt, von Feinden ereilt zu werden, und im Zusammenhang damit ist die für einen Kruster ungewöhnliche Sehschärfe von grossem Vorteil. Einen nahenden Menschen sehen sie auf ungefähr 30 m und vielleicht mehr; das Herannahen eines gehenden Menschen bis auf 10 - 14 m oder mehr hat schon eine Flucht in die Höhlen zur Folge.— Den grossen Spaziergängen zufolge gelingt es den Tieren oft nicht, bei nahender Gefahr gleich die Höhlen zu erreichen. Und da ist es interessant zu sehen wie sie eine Höhle in nächster Nähe aufsuchen, nach einiger Zeit aus dieser hervorkommen und ganz behutsam zur eigenen Höhle zurückkehren, wenn die Gefahr vorüber ist. Die auffallende Ortskenntnis, zusammen mit der grossen Gesichtsschärfe, sind für jeden, der diese grossen tropischen Krabben zum ersten Mal beobachtet, eine Überraschung. Die Sehschärfe betrifft hauptsächlich das Bewegungssehen: einem unbeweglichen Menschen nähert die Krabbe sich bis in sehr geringe Entfernung; aber es mag sein, dass hier nicht nur die geringe Sehschärfe, sondern die geringe Furcht vor nicht bewegenden Objekten mit eine Rolle spielt.

Die Höhlen der Tiere reichen, wie gesagt, bis in das Grundwasser. Es ist nicht wahrscheinlich, dass die Tiere sich jemals für längere Zeit im Grundwasser aufhalten. Wir werden bei der Behandlung von *Uca* sehen, dass das Grundwasser vor allem dazu dient, es den Tieren möglich zu machen, sich zu benetzen. *Sesarma taeniolata* ist funktionell eine ausgesprochene Lungenatmerin und entflieht bei Flut dem Wasser. Wenn es einige Tage pro Monat Springflut gibt, da werden auch die Schlammböden von *taeniolata* überströmt. Und dann kann man beobachten, wie Hunderte dieser merkwürdigen Krabben auf die Bäume, Pneumatophoren und Farnpflanzen klettern, sich dort an den Stämmchen, im Geäst oder an den Blättern festklammern, um bei nahender Gefahr sich herabfallen zu lassen. In ihren Höhlen sitzen sie denn auch meistens mehr oder weniger dicht unter der Oberfläche; erst bei drohender Gefahr gehen sie bis ins Wasser hinab <sup>1)</sup>. Man sehe auch Seite 242 ff.

<sup>1)</sup> Jeder Besucher der Mangrove wundert sich über einen merkwürdigen klat-schenden Laut, der fast überall zu hören ist. Ich habe nie entdecken können, von welchen Tier dieser Laut produziert wird, muss aber annehmen, dass er von *Sesarma taeniolata* herrührt, da man ihn an Stellen hört, wo keine andere Art — so scheint mir — in Frage kommt.



Wir sahen oben, dass die Mangrove, ausser von *S. taeniolata* und der ebenso grossen *S. meinerti*, in ihren niedrigen Teilen von zwei anderen *Sesarma*-arten: *bataviana* und *cumolpe*, bewohnt wird. Da diese beim Steigen des Wassers sich überströmen lassen, ist es interessant zu wissen, ob *taeniolata* unter Wasser eher stirbt als *bataviana* und sie längere Austrocknung erträgt als letztere. Weiter würde es interessant sein, die Atmung von *S. taeniolata*, einer Grapside, zu vergleichen mit der anderer auf dem trockenen wohnenden Arten, zum Beispiel der von *Uca*, einer Ocypode. Diese Vergleichung findet man im zweiten Teil.

Ausser von *Sesarma taeniolata* wird die erste Zone, wie schon gesagt, noch von einer zweiten *Sesarma*-art, nämlich *S. meinerti*, bewohnt. Morphologisch ist diese Art, besonders an den grossen Scheren, leicht zu unterscheiden; den biologisch-oekologischen Unterschied der beiden Arten kenne ich aber nicht. *Sesarma meinerti* ist an bestimmten Stellen nicht selten; sie scheint besonders noch etwas trocknere, höher liegende Stellen als *taeniolata* zu lieben; ich habe hierüber aber keine Gewissheit. Wo ich die Art sammelte, war sie stets viel weniger zahlreich als *taeniolata*.

Ausserdem lebt in der Mangrove, und zwar besonders (aber vielleicht nicht ausschliesslich) in der ersten Zone, eine Paguride, nämlich *Coenobita cavipes* STIMPSON. Obgleich sie bei Batavia die ganze Mangrove bis zur Nipa-zone bewohnt, scheint sie in der Nähe des Meeres zahlreicher als mehr landeinwärts zu sein. Auch diese Krabbe hat, wie schon gesagt, die Gewohnheit, beim Steigen des Wassers auf die Bäume zu klettern. Sie umklammert dabei mit ihren scharfgespitzten Beinen die Stämmchen und Äste und man kann bisweilen mehrere Exemplare von einer einzigen *Avicennia* pflücken. — Die verwandte *Coenobita rugosa* H. M.-Edw., obgleich auch wohl am Tage tätig, ist mehr Nacht- als Tagtier und omnivor. Sie geht offenbar nie ins Wasser und kann lange Zeit in ganz trockener Umgebung am Leben erhalten werden (siehe im zweiten Teil unter Atmung). Dabei schliesst das Tier das Gehäuse mit den Chelae ab, die ganz genau zur Gehäuseöffnung passen und als Operculum wirken. Genau die gleiche Lebensweise scheint *C. cavipes* in der Mangrove zu haben. Man sehe auch HARMS, p. 287 - 288.

Schliesslich haben wir noch die Schnecken zu besprechen, die den trockenen Boden bewohnen. Wie schon gesagt sind sie alle Lungenatmer, da sie beim Steigen des Wassers auf die Bäume klettern und so das Fallen des Wassers abwarten. Es sind *Cassidula auris-felis*, *C. mustelina*, *C. cumingiana*, *Cerithidea quadrata* und *obtusa*, *Littorina carinifera* und *scabra*. — Von den drei genannten *Cassidula*-arten fand ich *cumingiana* nur einmal in ganz dichtem *Rhizophora*-wald, es mag sein dass die Art in derartigem Wald zahlreicher vorkommt; die Tiere, nur zwei Exemplare, sassen auf den Bäumen über dem Wasserniveau. Von den beiden anderen Arten kann man erstere die überall gewöhnlichste nennen, obgleich ich, wie ich schon sagte, einmal auf einer einzigen Bank *mustelina* viel zahlreicher fand als *auris-felis*. — Von den beiden genannten *Cerithidea*-arten ist *quadrata* bei weitem die allgemeinste, von der grossen *obtusa* fand



ich immer nur einige Stück. *C. quadrata* ist vielleicht die zahlreichste Schneckenart des trockenen Mangrovebodens, genau wie *C. alata* die zahlreichste Art der niedrigen Bänke sein mag. Von den beiden *Littorina*-arten schliesslich ist *carinifera* viel zahlreicher als *scabra*, obgleich auch diese gar nicht selten ist.

## II. Die Zone von *Uca consobrinus* (DE MAN) (Tafel VI und XI).

Wie schon gesagt, bewohnt *Uca consobrinus* <sup>1)</sup> den obersten Teil der Schlammränke, der regelmässig vom Hochwasser erreicht wird. Wir sahen dass in der eigentlichen jüngeren Mangrove nur wenig Ränke hoch genug liegen um *Sesarma taeniolata* den Aufenthalt zu ermöglichen. Etwas ausgedehnter ist die Zahl der Ränke, die — jedenfalls teilweise — genügend hoch liegen um *Uca consobrinus* günstige Lebensverhältnisse zu bieten. Die Art scheint vor allem einen konsistenten, ziemlich harten Schlamm zu lieben, auf bewachsenem Boden zu fehlen. Man sehe Tafel VI.

Diese Art ähnelt in ihrer Lebensweise *Uca signatus*, die unten besprochen wird. Wie letztere kommt sie da, wo die Art überhaupt auftritt, in grosser Zahl vor, indem die Höhlen ganz dicht beisammen liegen. Die Höhlen sehen genau wie die von *Uca signatus* aus und reichen, wie die von *Sesarma*, bis ins Grundwasser hinab. Bei Flut wird der Schlamm überströmt und die Tiere ziehen sich dann in ihre Höhlen zurück. Sie sind, wie alle *Uca*-arten, Tagtiere.

Es besteht, wenn man *signatus* und *consobrinus* draussen beobachtet, ein kleiner Unterschied zwischen beiden Arten, der aber von geringer Wichtigkeit für uns ist; beim Winken schlägt *consobrinus* viel weiter aus als *signatus*. Dies ist die Folge eines morphologischen Unterschieds: der grosse Cheliped von *consobrinus* ist, auch in seinem basalen Teil, länger als der von *signatus*. — Übrigens sehe man für Besonderheiten über die Lebensweise von *consobrinus* (Futteraufnahme, Atmung) im zweiten Teil.

## III. Die Zone von *Uca signatus* <sup>2)</sup> (HESS) (Tafel VII und VIII).

Diese dritte Zone reicht von wenig unter dem Niveau des gewöhnlichen Hochwassers bis dahin, wo der Schlamm ganz feucht zu werden beginnt. Sie umfasst also den Teil der Schlammränke von mittlerer Härte. *Uca signatus* ist in der Mangrove bei Batavia mit *Metaplex* wahrscheinlich die zahlreichste Krabbenart und ich habe also am meisten mit dieser Art gearbeitet; auch schon deshalb, weil mir die Biologie dieser Art von ganz besonderem Interesse schien.

<sup>1)</sup> Nach DE MAN ähneln die Tiere aus der Umgebung von Batavia *Uca annulipes* (Latr.) H. M.-EDW., ohne aber mit dieser Art identisch zu sein. DE MAN benennt daher die hier studierten Tiere neu, und zwar gibt er ihnen den Namen *consobrinus*. Da er hierüber in kürzem eine Notiz veröffentlicht, gehe ich auf die Sache nicht näher ein. Bemerkt sei nur, dass die Scherenbasis der Männchen bei *consobrinus* rot, bei der echten *annulipes* gelb ist, und dass beide Arten in der Lebensweise Unterschiede zeigen. So lebt *consobrinus* hoch, auf trockenem Gebiet, *annulipes* niedriger. In Tjilatjap scheinen beide Arten vorzukommen.

<sup>2)</sup> Die Tiere aus der Nähe von Batavia wurden von DE MAN (1891, p. 38) als var. *angustifrons* beschrieben.



Die Gattung *Uca* erfreut sich einer grossen Bekanntheit, einer Eigentümlichkeit wegen, die auch in ihren vielen Namen zum Ausdruck kommt. *Gelasimus* (= *Uca*) bedeutet der Lächerliche. Die Deutschen nennen das Tier Winkerkrabbe, die Engländer „calling“, die Amerikaner „fiddler“ crab, die Holländer wenkkraab, die Japaner Siho maneki, was bedeutet „beckoning for the return of the tide“ (STEBBING), Namen welche sich alle beziehen auf das merkwürdige Winken des grossen Chelipeds (Tafel VII).

*Uca signatus* bewohnt die Mangrove vom Meer bis zur Nipa-zone, woraus man schliessen kann, dass der Salzgehalt des Wassers grosse Unterschiede zeigen darf. Die schönsten *Uca*-bänke findet man bei Batavia (und anderwärts) aber in der Nähe des Meeres, nicht weil die Tiere das reine Meerwasser lieben, sondern weil die reinen Schlamm-bänke besonders unweit des Meeres zu finden sind.

Die Lebensweise der Tiere ist nun kurz folgende:

Sie graben sich Höhlen, die, wie bei den schon besprochenen Arten, bis zum „Grundwasser“ hinabreichen, also bis zum Niveau niedriger Ebbe. Sie halten sich in diesen Höhlen im Wasser, oder am liebsten auf der Grenze zwischen Wasser und Luft auf. Jede Höhle wird nur von einem einzigen Tiere bewohnt. Bei niedrigem Wasser, wenn der Schlamm trocken fällt, kommen die Tiere aus den Höhlen hervor, aber normalerweise nur am Tage und ausserdem nur wenn es genügend warm ist. Sie gehen dann auf Nahrungssuche, was darin besteht, dass sie das oberste Schlamm-schichtchen fortfressen. Meistens ist das also jeden Tag ein neues. Der Schlamm wird vom kleinen Cheliped aufgenommen; das Männchen frisst also mit einem, das Weibchen mit zwei Chelipeden. Die Mundgliedmassen scheiden brauchbares von unbrauchbarem Material; letzteres häuft sich an der Aussenseite der dritten Maxillipede auf und wird als kleiner Schlamm-tropfen vom kleinen Cheliped fortgenommen und auf den Boden deponiert. Wo viele Krabben fressen, ist der Boden mit diesen kleinen Tropfen ganz bedeckt (Tafel XI!). Die Futtersuche findet in der unmittelbaren Umgebung der Höhlen statt; wenn sie Unrat merken wird die Höhle blitzschnell aufgesucht. Es ist also äusserst wichtig, dass Artgenossen, die benachbarte Höhlen bewohnen, nicht den Schlamm der Nachbarn auffressen, denn diese werden dadurch gezwungen, weit von ihren Höhlen entfernt auf Futtersuche zu gehen und sind dabei der Gefahr ausgesetzt, aufgefressen zu werden; Vögel stellen ihnen eifrigst nach. Es muss also die Möglichkeit bestehen, das Grundgebiet anzudeuten: dies geschieht durch das Winken. Der Futterüberfluss ermöglicht das Zusammenwohnen grosser Mengen dieser Tiere auf kleinem Gebiet. Eine unbeschränkte Zunahme der Krabben würde aber die Vorteile des Überflusses zunichte machen. Da jedes Individuum sein Territorium abpfählt, kann die „Kolonie“ sich nur nach aussen ausbreiten, und wenn die Aussengrenzen erreicht sind, ist weitere Zunahme an dieser Stelle unmöglich. Obgleich die Tiere diesen gewaltigen Futterreichtum finden ist der Kampf ums Dasein hier nicht weniger heftig als anderswo in der Welt. — Es sind viele Hypothesen über die Bedeutung des Winkens geäussert worden; dass es eine Territorium-



begrenzung bedeutet, ist neu; weiter unten wird man sehen, weshalb ich dieses als Tatsache, nicht als Hypothese gebe. Was die Fortpflanzung der Art anbelangt, sei nur bemerkt, dass die Jungen, wie die der verwandten Arten, in dem Zoaeastadium aus dem Ei kriechen.

Ausführlichere Besonderheiten über die Lebensweise von *signatus* findet man im zweiten Teil.

Wie schon gesagt wird die dritte Zone, ausser von *Uca signatus*, von einer zweiten Krabbenart, *Ilyoplax delsmanni* DE MAN, bewohnt (Tafel VIII, oben). Diese Art scheint im allgemeinen etwas härteren, festeren Untergrund als *signatus* zu lieben, weshalb man an mehreren Stellen *delsmanni* nur im oberen Teil der Zone findet; sie kommt aber an andern Stellen überall in der dritten Zone vor, unten sowohl wie oben.

*Ilyoplax delsmanni* ist, obgleich sie fast nirgends fehlt, selten allgemein. Es kommt meistens auf einige Zehntel *signatus* ein einziges Exemplar von *delsmanni* vor. — Übrigens hat diese Art hauptsächlich die gleiche Lebensweise wie jene Art. Es werden Höhlen gegraben, die, entsprechend der geringen Grösse der Art, einen kleineren Durchmesser als die von *signatus* haben; *Ilyoplax* ist Tagtier, das nur herauskommt, wenn die Sonne hoch genug gestiegen ist, und sie frisst wie die *Uca*-arten Schlamm.

*Ilyoplax delsmanni* weicht von den *Uca*-arten darin ab, dass die beiden Chelipede von gleicher Grösse sind. Es versteht sich also, dass das Fressen beim Männchen *delsmanni* in anderer Weise wie beim *signatus*-männchen stattfinden muss und das gleiche gilt in bezug auf das Graben der Höhlen. Ich bespreche das kurz im zweiten Teil. Es ist nun äusserst interessant, dass diese Art, obgleich sie im männlichen Geschlecht zwei grosse Chelipede hat, funktionell zur Gruppe der Winkerkrabben gehört, da sie, genau wie diese, winkt. Das Winken findet hier mit beiden Scheren statt und zwar in der Weise, dass sie gleichzeitig nach aussen und wieder zurückgeklappt werden. Weiter gehört zum Winken ein merkwürdiges Zittern, wobei das Tier die fast geschlossenen Chelipede sehr schnell hin und her bewegt, was mit dem Winken sensu stricto abwechselt. Das Zittern wird heftiger, je näher ein Nachbar heran kommt. *Ilyoplax delsmanni* ist auch dadurch merkwürdig, dass sie ihr Aussehen sehr schnell ändern kann. Die normale Farbe, die durch die Anwesenheit gelber und schwarzer Pigmentzellen zu stande kommt, ist grau; Tiere dieser Farbe sind schwer vom Schlamm Boden zu unterscheiden. Die winkenden Männchen aber, die unweit ihres Höhleneinganges sitzen, sehen auf dem Rückenschild weiss bis weissgrau aus und fallen dadurch sehr stark auf (Tafel VIII). Fängt man die Tiere nun, so werden die schwarzen (auch gelben?) Pigmentzellen kontrahiert und Schild sowie Scheren sehen wieder grau aus. Aus der Tatsache, dass nur die Männchen weiss sind, und zwar nur solange sie zum Winken neigen, liesse sich vielleicht schliessen, dass die weisse Farbe den Zweck hat, die Tiere auffallen zu lassen. Das gleiche wird von den *Uca*-arten durch die hellen Farben der Scheren und des Rückenschildes erreicht. Es würde interessant sein zu untersuchen was die Kontraktion und Expansion



der Chromatophoren bewirkt, ob sie nervöser oder anderer Natur ist und welcher Reiz hier eventuell eine Rolle spielt; besonders die in den letzten Jahren an Garneelen angestellten Versuche über das Vorkommen eines Hormons im Augensiel, das die Kontraktion der Melanophoren bewirkt, sind interessant; siehe auch die übersichtliche Zusammenfassung verschiedener Einflüsse auf den Farbwechsel bei BALLS, p. 928 - 929.

Über den zwischen *Uca signatus* und *Metaplex elegans* vorkommenden *Uca urvillei* machte ich keine Beobachtungen. Ich sammelte sie bei Batavia nur an einigen Stellen. Man sehe auch bei der Behandlung der vierten Zone.

Wie gesagt lebt in der *signatus*-zone, und zwar in der unteren Hälfte, eine kleine Schnecke: *Assiminea brevicula* PFR. Auffallend genug zeigt das Tier im Prinzip die gleiche Lebensweise wie die beiden Krabben dieser Zone. Wird der Schlamm überflutet, so haben die Schnecken sich in Höhlen und Risse zurückgezogen. Fällt das Wasser, so kommen die Tiere wieder zum Vorschein; aber nicht bevor die Sonne den Schlamm zu erwärmen anfängt. Besucht man die Mangrove kurz und sogar noch eine Stunde nach Sonnenaufgang, so sieht man nicht nur keine Krabben, sondern man findet alle *Assiminea* unter der Oberfläche; und zwar sitzen sie in grosser Zahl in den Eingängen und oberen Teilen der Krabbenhöhlen. Je höher die Sonne steigt, desto mehr kommen sie zum Vorschein und desto aktiver werden sie. Sie huschen dabei schnell vorwärts, indem mit jedem Ruck eine einzige Kontraktionswelle über die Fusssohle von hinten nach vorn gleitet. Es bestehen Tiere mit roten und solche mit grauen Häuschen. Die Tiere fressen Schlamm. Fräulein VAN BENTHEM JUTTING (1922) hat beschrieben wie *Assiminea grayana* in grosser Zahl paarweise über den Schlamm kriechend von ihr beobachtet wurde. Die Paare bestanden aus einem Weibchen, das ein Männchen trug. Genau das gleiche lässt sich unter Umständen, besonders während der Morgenstunden, bei *A. brevicula* beobachten.

#### IV. Die Zone von *Metaplex elegans* DE MAN.

Global gesagt fängt die Zone von *Metaplex elegans* da an, wo man in den Schlamm einzusinken beginnt. Die Tiere sind also noch kürzer ausserhalb des Wassers als *Uca signatus* und *Ilyoplax deltsmani* und damit hängt die Tatsache zusammen, dass man sie oft unter Wasser Schlamm fressen sieht.

Wie gesagt kann man die vierte Zone dadurch in zwei Subzonen teilen, dass die verwandte Art *Paracleistostoma depressum* einen noch feuchteren Schlamm als *Metaplex elegans* liebt. Wo *Paracleistostoma* lebt, sinkt man an manchen Stellen bis zur halben Beinhöhe in den Schlamm hinein.

Beide Arten, die in ihrer Zone sehr häufig sein können, zeigen den Charakter, der für alle Mangrovekrabben typisch ist, zeigen aber andererseits auffallende Unterschiede gegenüber den *Uca*- und *Sesarma*-arten. Wie alle Mangrovekrabben hängen sie in so weit nicht vom Salzgehalt des Wassers ab, dass sie die Mangrove vom Meer bis zur Nipa-zone bewohnen; wenn es wenigstens Schlammröhren oder mehr oder weniger offene Stellen im Wald gibt. Sie graben Höhlen, die nicht sehr tief zu sein brauchen, da sie nur wenig über dem Niveau des nie-



drigsten Wasserstandes liegen. Fällt der Schlamm trocken, so kommen sie aus diesen Höhlen hervor, aber manchmal laufen sie fressend umher, wenn der Schlamm noch (oder schon?) unter Wasser steht und dabei lieben die Tiere den hellen Tag weniger als schwache Beleuchtung, so dass sie in der Morgenfrühe zahlreich sein können, wenn *Uca* noch fehlt und am Tage ganz fehlen können, wenn *Uca* zahlreich ist. Es mag aber sein, dass die Temperatur hier von Einfluss ist. Wahrscheinlich ertragen *Metaplex* und *Paracleistostoma*, genau wie *Sesarma* (jedenfalls *Sesarma bataviana*) nicht die grosse Hitze, welche von den *Uca*-arten ertragen wird. — Wir werden weiter unten, bei der Behandlung von *Uca signatus*, sehen, dass letztere Art, wenn das Hochwasser während des Tages fällt, auch frühmorgens hervorkommt; in gleicher Weise kommt *Metaplex* zahlreich am Tage zum Vorschein wenn das Hochwasser während der Nacht fällt.

Wie die *Uca*-arten fressen *Metaplex* und *Paracleistostoma* Schlamm ohne weiteres, weichen also von den *Sesarma*-arten darin ab, dass sie, jedenfalls als Regel, nicht den Schlamm nach größerem Abfall absuchen. Auch das Männchen arbeitet dabei, wie das *Ilyoplax*-männchen, mit beiden Cheliceren. Wenn unter der Wasseroberfläche Schlamm gefressen wird, nimmt der Strom des Atemwassers das unbrauchbare Material automatisch mit; sonst, auf dem trockenen, wird der verweigerte Schlamm niedergelegt wie das bei *Uca* normal ist.

Die Futtersuche findet, wie bei *Uca*, nur in der unmittelbaren Umgebung der Höhlen statt; dennoch winken *Metaplex elegans* und *Paracleistostoma* nicht. Man fragt sich, weshalb diese Tiere, die viel friedlicher sind als *Uca* und sich nicht streiten, nicht unter Futterarmut leiden.

Die Fortpflanzung dieser Arten ist von der von *Uca* nicht verschieden. Die Eier werden auch hier unter dem Abdomen mitgetragen und die Larven kriechen als Zoaëa aus. Die Larven von *Paracleistostoma* (die von *Metaplex* kenne ich nicht) unterscheiden sich aber von denen von *Uca* und anderen durch das Fehlen des Rückenstachels.

Wir wissen schon, dass ausser den beiden oben besprochenen Arten zwei *Sesarma*-arten diese gleiche Zone bewohnen, und zwar sind das: *Sesarma bataviana* und *Sesarma cumolpe*. Wie *Sesarma taeniolata* und *S. meinerti* sind diese Arten mehr Dämmerungs- als Tagtiere. Sie sind sehr zahlreich in der Morgendämmerung und verschwinden allmählich, wenn *Uca* zum Vorschein kommt. Sie ertragen weniger hohe Temperaturen als *Uca* (man sehe im zweiten Teil). Sie suchen ihre Nahrung genau wie die anderen *Sesarma*-arten, indem sie den Schlamm nach organischen Stücken absuchen. Dabei spazieren sie weit umher und besuchen manchmal auch den höher gelegenen Schlamm: so zum Beispiel findet man *Sesarma bataviana* regelmässig in der dritten Zone auf der Nahrungssuche; gelegentlich mögen sie, besonders während der Nacht, sogar die zweite Zone besuchen. Auch diese Arten graben sich Höhlen, die bis ins Grundwasser reichen. Überströmt das Wasser den Schlamm, so bleiben sie unten; sobald der Schlamm freikommt, gehen sie auf die Nahrungssuche. Bisweilen (besonders in den Terrarien, wenn sie da Hunger kriegen) fressen sie unter Wasser. Sie sind omnivor.



Es besteht ein Unterschied zwischen *Sesarma bataviana* und *Sesarma cumolpe*, was die Wahl des Bodens anbelangt. *Sesarma bataviana* hält sich offenbar besonders gern da auf, wo es kahlen Schlamm gibt, *Sesarma cumolpe* dagegen liebt den Wald. Es mag sein, dass die Art der Nahrung eine Rolle spielt; jedenfalls aber findet man *cumolpe* hauptsächlich unter Bäumen, und an dergleichen Stellen kann sie ebensozahlreich sein wie *bataviana* da, wo Holz fehlt. Aber *bataviana* kommt nichtsdestoweniger auch im Wald vor <sup>1)</sup>).

Beide Arten pflanzen sich fort wie die bis jetzt besprochenen. Die Eier werden unter dem Abdomen mitgetragen und kommen im Zoaea-stadium aus. Einige nähere Angaben hierüber findet man im zweiten Teil.

Ziemlich selten kommt bei Batavia in der dritten und vierten Zone *Uca urvillei* vor. Ich studierte diese Art in der Gefangenschaft an Material aus Piroe, West-Ceram, das mir von Frau BRINK-VAN MULLEM zugeschickt wurde. Bei Batavia kommt die Art nur sehr wenig vor. Ich fand sie zusammenlebend mit *Uca signatus* und *Metaplex elegans*; sie scheint also einen Teil der Zonen III und IV zu bewohnen.

Die Schnecken dieser Zone sind: *Terebralia sulcator* und *Cerithidea alata*, *Salinator burmana* und *Haminea* spec. Oben treffen wir *Assimineae brevicula* noch an, unten *Telescopium telescopium*.

Von diesen Arten gehören *Cerithidea alata* und *Telescopium telescopium* eigentlich in die fünfte Zone, obgleich man sie allgemein auch in der vierten findet. Auf dem inneren, nicht am Wasser grenzenden Teil der Bänke, kommen diese Arten (wie alle anderen) nämlich ebensogut vor wie auf dem äusseren Teil, und man findet sie da zwischen *Assimineae*, *Haminea*, u.s.w., weil hier die schlechten Abwässerungsverhältnisse die Zonen zusammenschieben; man findet da sogar Tiere aus der II. bis IV. Zone durch einander. An der Aussenseite der Bänke aber wohnt *Assimineae* zusammen mit *Uca signatus* und *Metaplex elegans*, während *Cerithidea alata* unterhalb *Metaplex* lebt, also in der fünften Zone. *Terebralia* und *Salinator* fand ich, und zwar einmal, nur auf dem inneren Teil der Schlammränke; die Unterbringung dieser Arten an diese Stelle ist also provisorisch. *Haminea* fand ich in grosser Zahl auf vielen Bänken; aber fast stets nur auf dem inneren Teil, nicht am äusseren Abhang. Fast überall, wo sie zusammen mit *Assimineae* vorkommt (denn *Assimineae* bewohnt ebensogut den inneren Teil wie den äusseren Abhang), lebt *Assimineae* höher, *Haminea* niedriger. *Salinator burmana* scheint in dem von mir untersuchten Gebiet wenig vorzukommen. Ich kenne die Art nur von einer einzigen Stelle, sammelte sie da nicht einmal selbst. Sie ähnelt in der Lebensweise offenbar *Assimineae*, kriecht gern ziemlich tief durch den Schlamm und frisst zweifellos Schlamm wie *Assimineae*. Ich studierte diese Art nämlich einige Zeit in meinen Schlammterrarien im Laboratorium. — Die *Haminea*-art endlich ist an vielen Stellen in der Mangrove gemein, wo der Schlamm genügend nass ist. Sie ist zwar viel weniger

<sup>1)</sup> Von *Sesarma cumolpe* beobachtete ich bei Erregung ein Zittern mit den Scheren, ähnlich dem von *Ilyoplax* und *Uca*. Ich erinnere mich nicht, dieses Zittern je von den anderen *Sesarma*-arten beobachtet zu haben.



allgemein als die überall vorkommende *Assiminea*, fehlt aber an den für sie geeigneten Stellen, jedenfalls in der von mir am besten untersuchten Moeara Petjah, fast nirgends. Auch diese Art kriecht gern halb unter dem Schlamm und verschwindet wenn die Sonne nicht scheint. Es ist interessant diese Art, die zu den Bulliden gehört, sich fortbewegen zu sehen. Darüber an anderer Stelle.

#### V. Die Zone von *Scylla serrata* (FORSKAL).

Der gelegentliche Mangrovebesucher bekommt die fünfte Zone, ausser auf dem inneren Teil der Bänke, nicht oft zu sehen. Denn nur bei niedrigem Wasserstand wird der Untergrund dieser Zone freigelegt, wobei auch die Höhlen von *Scylla* sichtbar werden. Diese Art geht aber ausserdem in tieferes Wasser herab, denn sie lebt in den Gewässern, die die Mangrove durchqueren und in den Fischteichen.

*Scylla serrata*, die bekannte Kepiting der Malaier, the Mangrovecrab der Australier, erfreut sich einer grossen Popularität. Der Grund ist der, dass die Art, genau wie *Homarus* in Europa, als Leckerbissen, besonders von Chinesen, hoch geschätzt wird. Grosse Exemplare werden in Batavia für 7 - 7.5 Cent pro Stück verkauft (1 dollar = 250 cent).

*Scylla serrata* gräbt sich, genau wie die anderen besprochenen Krabbenarten, Höhlen, die, da sie so niedrig vorkommen, bei dieser Art meistens fast horizontal bis schief nach unten verlaufen. VAN KAMPEN (1909) hat ausführlich beschrieben, wie man die Tiere fängt. Man steckt hier und da, besonders am Rand der Fischteiche, Bambusstöckchen in den Boden, an deren Ende eine Schnur mit einem eisernen Ring befestigt ist. An diesen wird ein Stück Fischfleisch oder sonstiges befestigt. Wenn die Kepiting versucht, dies abzureissen, wird das Stöckchen vorsichtig in die Höhe gehoben und zu gleicher Zeit wird ein kleines Netz unter die Krabbe gebracht. — Eine andere Fangmethode besteht darin, dass man die Löcher aufsucht. Man benutzt dann einen dünnen Stock, an dessen Ende ein starker, hakenförmig gebogener Eisendraht befestigt ist. Der Stock wird ins Loch hineingebracht und nach vorn und hinten bewegt. Die Krabbe wird in dieser Weise angehakt. — Eine dritte Fangmethode besteht darin, dass ein oben und unten offener Bambuskorb in den Schlamm gesteckt wird an der Stelle, wohin sich eine *Scylla* flüchtete oder wo eine erwartet wird. Das Gitter des Korbes, der auch zum Fischfang benutzt wird, endet unten in scharfe Spitzen. Man rührt darauf mit dem Haken im Korb, um diesen nach einer Krabbe abzutasten. Die Methode wird angewendet, wo man eine nicht zu hohe Schlamm-schicht auf festem Boden hat.

Von den bis jetzt behandelten Krabben ist *Scylla serrata* die erste, die nie oder fast nie aus dem Wasser herauskommt. Sie hängt dadurch viel weniger als die anderen Krabben vom Wasserstand ab und nur ein Teil der Tiere wird bei niedrigstem Wasserstand gezwungen werden, die Höhlen aufzusuchen. Sie scheinen sowohl während des Tages wie in der Nacht aktiv zu sein, werden jedenfalls auch nachts gefangen.



Als Aas wird beim Fang Fischfleisch benutzt, wahrscheinlich sind die Tiere, wie die *Sesarma*-arten, omnivor; wobei aber die *Sesarma*-arten mehr Herbi- als Carnivore sind, *Scylla* umgekehrt wahrscheinlich mehr Carnivor ist. Was die Fortpflanzung anbetrifft, die Eier werden mitgetragen unter dem Abdomen, die Larven werden, wie die der verwandten radjungans (*Neptunus*) (vgl. DELSMAN & DE MAN, 1925) im Zoaeastadium auskommen.

Wie schon gesagt ist für den unteren Abhang der Schlammbänke *Cerithidea alata* Charaktertier. Es ist anziehend zu sehen wie bestimmte Bänke von Hunderten dieser Tiere bevölkert werden; ihre Kriechspuren und Häuser verleihen dem Untergrund ein typisches Gepräge und man versteht das Interesse der Palaeontologe für diese herrlichen Gebiete, in deren Boden sich das Tiertreiben eingraviert, wie in die Kupferplatte die Radiernadel (Tafel VIII, unten). *Cerithidea* hat, so viel ich feststellen konnte, die gleiche Lebensweise wie *Assimineae*. Unter Wasser frisst sie wenig oder nicht; fällt das Wasser, so ist sie, besonders in der Sonne, aktiv und frisst Schlamm oder jedenfalls Bestandteile der Oberfläche. Sie scheint sich, wenn das Wasser steigt, mehr oder weniger in den Schlamm eingraben zu können, die Tiere sind dann fast unsichtbar; bisweilen findet man sie bei niedrigem Wasserstand denn auch mit einer grossen Menge Schlamm überdeckt.

Es lebt in dieser fünften Zone ausserdem die grosse Cerithiide *Telescopium telescopium*. Den Tieren dieser Art wird ziemlich eifrig nachgestellt, da sie von den Malaiern gern gegessen werden.

Die Zahl der Tierarten dieser fünften Zone mag grösser sein, ich kenne diese Zone aber ungenügend. Nur will ich nicht versäumen merkwürdige Bildungen zu nennen, die man bei niedrigem Wasserstand sehr viel an geeigneten Stellen antreffen kann: die Höhleneingänge der Brutnester von *Periophthalmus* und *Boleophthalmus* (Tafel IX, oben). Im ganz schlammigen, bei niedrigem Wasserstand noch gerade trockenfallenden Schlamm begegnet man hier und da von einem deutlichen Ringwall umgebenen Trichtern, die, bei einem Durchmesser von 25 - 100 cm, in der Mitte eine Tiefe von höchstens etwa 20 cm erreichen. In der Mitte befindet sich ein Höhleneingang, und dieser führt in einen Gang, der schief oder gerade nach unten geht, bis zu 1 m (oder auch mehr?) unter der Schlammoberfläche. Nähert man sich dem zum Trichter gehörenden *Periophthalmus*, und zwar werden die grossen Löcher in meinem Beobachtungsgebiet besonders von *Boleophthalmus boddaerti* (PALL.) und *Periophthalmus schlosseri* (PALL.) gemacht, so wird das Tier sich in das Wasser der Kummern flüchten und darauf in die Höhle verschwinden. Man kann dann das Tier am Ende des Ganges, in einer Tiefe von 1 Meter unter der Oberfläche, zurückfinden.

Die Höhlen wurden zuerst von PETIT beschrieben. HARMS (p. 277 - 278) beschreibt sie für *P. schlosseri* und *P. argenteolineatus*. Nach diesen Angaben dienen die betreffenden Höhlen ausschliesslich zum Ablegen der Eier. HARMS hielt *Boleophthalmen* sowie *Periophthalmen* in einem Gewächshaus des Botanischen Gartens zu Buitenzorg, in dem er „Sumpfmangrovelandschaften“ einrichtete. Er beobachtete das Bauen eines Nestes bei *P. argenteolineatus* und *chrysospilos* und fand einmal Eier am Grunde der



Brutkammer an einem flachen Stein angeklebt. Das Brutnest wird nach HARMS vom Weibchen nur auf kurze Zeit zur Futteraufnahme verlassen, bleibt aber dabei stets bewacht. Fremde Tiere werden weggebissen. Wird das Tier beunruhigt, so zieht es sich in seine Bruthöhle zurück. Wie ich sagte kann man es dann unten in der Höhle zurückfinden. — Nach HARMS können die Gänge bei *P. schlosseri* mehrere Meter Länge haben.

#### Besprechung weiterer Arten und Zusammenfassung der Angaben über Zonenbildung.

Wir haben schliesslich noch *Macrophthalmus definitus* und *Thalassinia anomala* zu besprechen.

*Macrophthalmus* scheint sich nicht auf eine bestimmte Höhe zu beschränken, sondern sowohl hoch als niedrig vorzukommen. Ich kenne die Art sehr ungenügend. Es kommen in den höhern wie in den niedrigen Gebieten (ich fand sie in der I. bis IV. Zone) kleine Hügelchen vor, die oben geschlossen und aus groben Schlammklumpen zusammengesetzt sind. Nimmt man sie fort, so findet man eine ziemlich kleine Öffnung und verfolgt man den Gang, so weitet er sich, biegt scharf nach links und rechts und führt bis in den ganz nassen Schlamm. Es ist mir einmal gelungen den Einwohner dieser Höhle auszugraben und zwar fand ich *Macrophthalmus*. Weiter fand ich diese Art einige Male zufälligerweise, während ich andere Tiere ausgrub. Sie scheint eine nächtliche Lebensweise zu haben; jedenfalls kam sie im Terrarium während der Nacht hervor und lieferte da auch die groben Schlammklumpen. Einmal wurden zwei Stück von meinem Bedienten am Tage bei niedrigem Wasserstand auf dem feuchten Schlamm fressend angetroffen. Wahrscheinlich war der hohe Wasserstand während der Nacht die Ursache dieses Taglebens. PEARSE (1912, p. 129) gibt an, dass „the fiddler's chief competitors for the food on the mud flats are ..... two species of *Macrophthalmus* whose feeding habits and food are very similar to those of the fiddler, but that usually live farther from the shore in the deeper parts of the estuaries and hence overlap the fiddler zone on the lower side only”. WARD (1928, p. 245) sagt von dieser Art: „As the name implies, these crabs have long eyestalks which enable them to lie halfburied in the surface silt and yet be cognizant of the doings of enemies”. Und weiter: „Two species inhabit the estuaries of Port Jackson. These do not move about the surface as much as *Heloeius cordiformis*, but form shallow runways or trenches leading to the burrows, and spend much of their time seated in these slowly feeding, with eyes erected on the lookout for possible enemies.” — Ich kann noch hinzufügen, dass diese Art bei Berührung sogenannten Scheintod zeigt, wobei die Scheren und Füsse fest gegen den Körper gepresst liegen. Das gleiche wurde von WHITLEY & BOARDMAN (1929) für *Actaea tomentosa* beschrieben und abgebildet. BALLS in KÜENTHAL (p. 960) entnehme ich, dass das Sichtotstellen auch vorkommt bei *Dromea*, *Lupa*, *Parthenope*, u.a. Man sehe übrigens MANGOLD (1914), der seine Angaben POLIMANTI (1912) entnimmt.



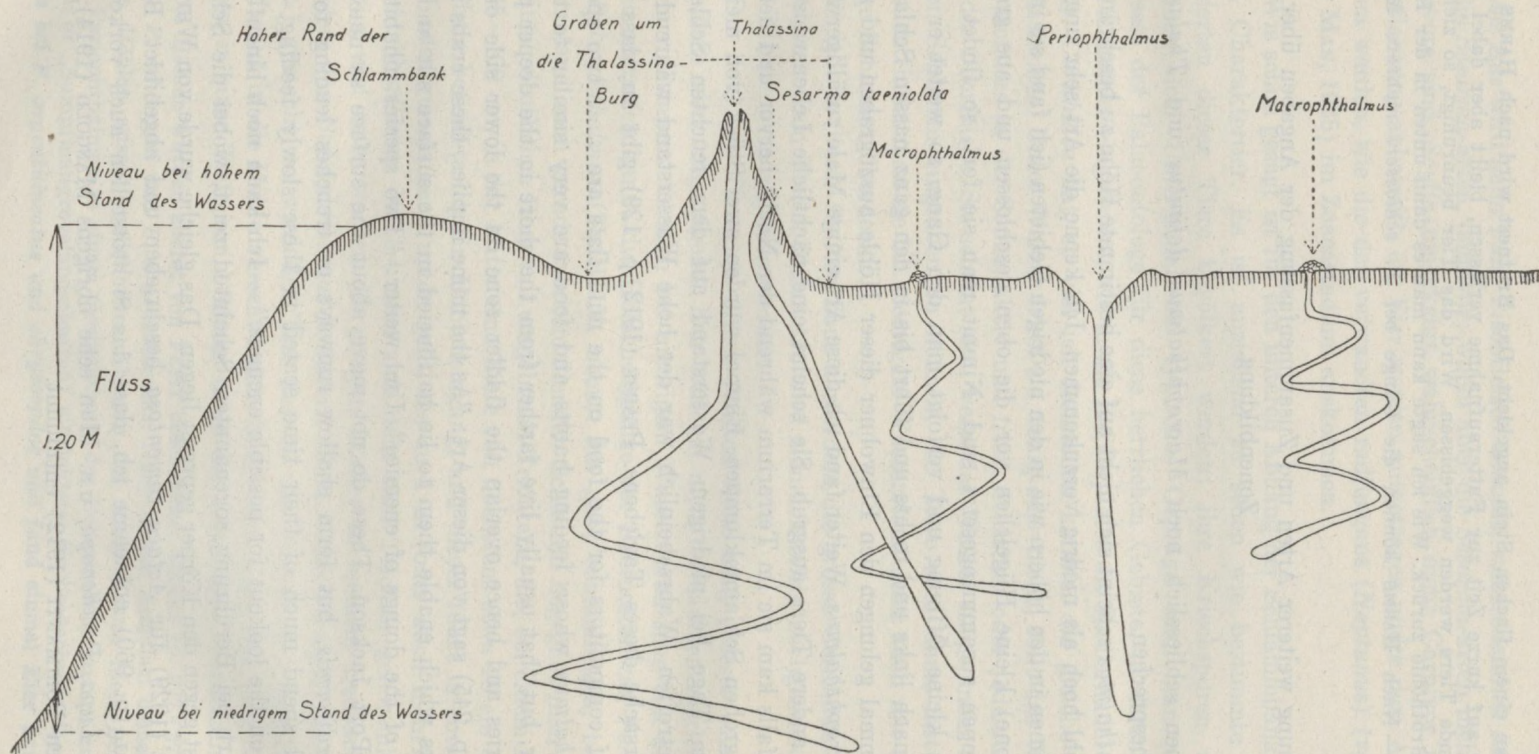


Fig. 2. Idealer Durchschnitt durch eine Mangroveschlammbank mit dem hohen Aussen- und dem niedrigeren Innenteil. Höhlen von *Thalassina anomala*, *Macrophthalmus definitus* und *Periopthalmus* oder *Boleophthalmus*.



Auch *Thalassina anomala* kommt ziemlich überall in der Mangrove vor, nicht nur vom Meer bis zur Nipa-zone, sondern ausserdem sowohl auf den höher als auf den niedriger liegenden Bänken. Die Art ist aber am zahlreichsten auf den niedrigen Bänken mit ganz feuchtem Schlamm. Da drängt dieser Krebs sich dem gelegentlichen Besucher schon von weitem auf. Er bildet da nämlich Komplexe hoher Burgen, die einen integrierenden Bestandteil des Brackwasser-morastes bilden. Man sehe Tafel IX, unten, und die Tafeln XII - XIV.

*Thalassina* ist mit den Paguriden verwandt, trägt den Hinterleib aber gestreckt. Die Art ist ganz speziell zum Graben eingerichtet und es ist denn auch reizend sie an der Arbeit zu sehen. Besonders mit Hilfe der beiden vorderen Pereiopodenpaare und der 3. Maxillipede gräbt das Tier sich in den Boden ein. Es trägt den Schlamm dabei nach aussen und legt ihn um den Höhleneingang herum. Je tiefer das Tier sich eingräbt, desto höher kommt der Schlamm um den Höhleneingang zu liegen, wodurch die Höhle fortwährend sich nach oben verlängert und der Höhleneingang nach oben geschoben wird. Es bildet sich in dieser Weise ein hoher Schlammhaufen, mit einem Schornstein auf der Spitze (Tafel IX). Besonders die Schornsteine, die auch für junge Haufen typisch sind (Tafel XII), weisen darauf hin, dass die Höhlen von *Thalassina* und zum Beispiel nicht von *Sesarma taeniolata* herrühren. Hackt man die Schlammhaufen auf, und verfolgt den Gang, so findet man, dass dieser, geradeaus oder schief nach unten verlaufend, das Grundwasser erreicht und darin eine ganze Strecke weiter läuft, meistens, mit einigen scharfen Biegungen, schief nach unten. Bisweilen gibt es auch einen Seitengang, dies scheint aber nicht Regel zu sein. Der Gang ist anfangs stets von gleichem Durchmesser, 7 - 8 cm für grössere Exemplare, wird unten von grösserer Breite, und endet schliesslich blind. Am Ende findet man dann den Krebs. Die Höhle hat also, wie auch SUNIER (1922) schon beschrieb, keine Kommunikation mit dem Wasser der Mangroveflüsse oder Fischteiche. Die Länge der Höhle unter dem Wasser beträgt bis zu 1.5 m und mehr; es gelang mir nicht, diese längeren Gänge bis zu Ende zu verfolgen, da sie sehr tief gehen, sich zwischen Baumwurzeln hindurchwinden, oft biegen, und dabei unter Wasser verlaufen. Während jüngere Höhlen (welche kleinere Tiere beherbergen) nur Schornsteine von 50 cm tragen, findet man hier und da gewaltige Burgenkomplexe (Tafel XIV, unten), deren Hügel eine Höhe von 1.— bis 1.5 m und am Boden einen Umfang von 3 - 4 m haben. Ja, ich sah sogar Komplexe, die eine Breite von 2, eine Länge von 3, und an der Basis einen Umriss von ungefähr 10 m hatten; derartige Komplexe tragen mehrere Schornsteine und sind zweifellos das Resultat langedauernder Arbeit mehrerer Tiere. Hackt man sie auf, so findet man denn auch mehrere Höhlen. Diese gewaltigen Burgen sehen alt und verwittert aus und sind mit ihrer Umgebung zu einem harmonischen ganzen verwachsen. Fast stets tragen diese alten Hügel Farnpflanzen, und zwar *Acrostichum aureum*. Diese Farnen sind auf halb trockenem Gebiet zu Hause (sie sind zum Beispiel ein Hauptbestandteil der Flora der trockenen Innenzone), finden auf den trockenen Hügeln aber eben so gute Lebensbedingungen wie dort und machen aus den kahlen, schwarzen Hügeln Lebensgemeinschaften



für sich. Die Hügel werden oft von *Sesarma taeniolata* bewohnt, die ihre Höhlen in den harten Schlamm gräbt und auf den Hügeln und um sie herum lebt. Auch fand ich bisweilen *Uca* auf den Hügeln wohnend. — Steigt das Wasser, so ragen die oberen Teile der Hügel wie mit Farnen bewachsene Inselehen über der Wasseroberfläche empor. Hackt man diese grossen Hügel auf, so entdeckt man, dass der alte, mit Ästen bedeckte Boden unter dem Hügel bis zu ziemlicher Tiefe (einige Dezimeter) weggesunken sein kann, während ein Wasserpfuhl um den Hügel herum oder neben ihm, auch wo letzterer auf etwas trockenerem Boden steht, deutlich zeigt, was Minierung einerseits und das schwere Gewicht des Hügels andererseits bewirkt haben (Tafel IX!).

Soviel ich weiss kommt *Thalassina* nur selten aus den Höhlen heraus. Ein Fisher erzählte mir, dass die Tiere bei hohem Wasserstand wohl die Höhlen verlassen, dass sie darauf nicht immer im Stande sind die Höhlen zurückzufinden und dass man ihnen deshalb nach hohem Wasserstand bisweilen begegnet. In wieweit diese Wahrnehmung richtig ist, kann ich nicht sagen. Weiter sagt PEARSE (1914), der auch mitteilt, dass *Thalassina* durch Stridulation einen Laut produziert (p. 425), dass diese Art nachts aus den Höhlen hervorkommt und dass *Thalassina* und *Cardisoma* "often stupidly sit in great numbers, dazed by the glare of a light". Man fragt sich aber, ob es sich hier wirklich um *Thalassina anomala* handelt, denn an anderer Stelle (1912, p. 129) sagt er von *Thalassina*: "sometimes exceeding the fiddlers in size." Wie dem auch sei, fest steht, dass der Magen Schlamm enthält und dass die Tiere diesen Schlamm unter der Oberfläche aufnehmen müssen (oft liegen die Schornsteine auf hohem, ganz trockenem Gebiet, wo feuchter Schlamm ganz fehlt). Wir haben hier also mit einem idealen Schlammtier zu tun, denn stellt man die behandelten Tiere noch einmal zusammen in der Reihenfolge, in der sie stets weniger vom Tageslicht sehen, so erhalten wir: *Sesarma taeniolata* und *meinerti*, *Uca annulipes*, *U. signatus* und *Ilyoplax* (je niedriger sie leben, desto länger werden sie vom Wasser überströmt, desto länger also befinden sie sich unter der Oberfläche), *Metaplex elegans* c.s., *Scylla serrata*, *Thalassina anomala*. Nur von *Scylla* weiss ich nicht, wieviel sie unter normalen Umständen über oder unter der Schlammoberfläche verbleibt.

Wenn wir nun schliesslich an der Hand eines idealen Durchschnittes durch eine Mangroveschlammbank noch einmal einige Resultate überblicken, so sehen wir, dass die genannten Arten ihre Höhlen alle bis ins „Grundwasser“ graben, also bis dahin, wo bei ganz niedrigem Wasserstand noch Wasser steht. Sobald denn auch der Wasserstand ganz besonders niedrig ist, sieht man allorts um die Höhleneingänge herum neuen, nassen Schlamm, der aus der Tiefe heraufgebracht wurde, da das Ende der Höhlen ungenügend im Wasser lag. Aus der Gezeitenkarte kann man ersehen, wie wichtig zwei Mal pro Monat der grösste Unterschied zwischen hohem und niedrigem Wasserstand ist.

Es lässt sich hieraus schliessen dass die Zonenbildung von der Art des Futters bedingt sein muss. Jede Art hält sich ganz streng an seine Zone, da diese ihr optimale Futterbedingungen liefert. Sogar die *Sesarma*-arten, die bei der



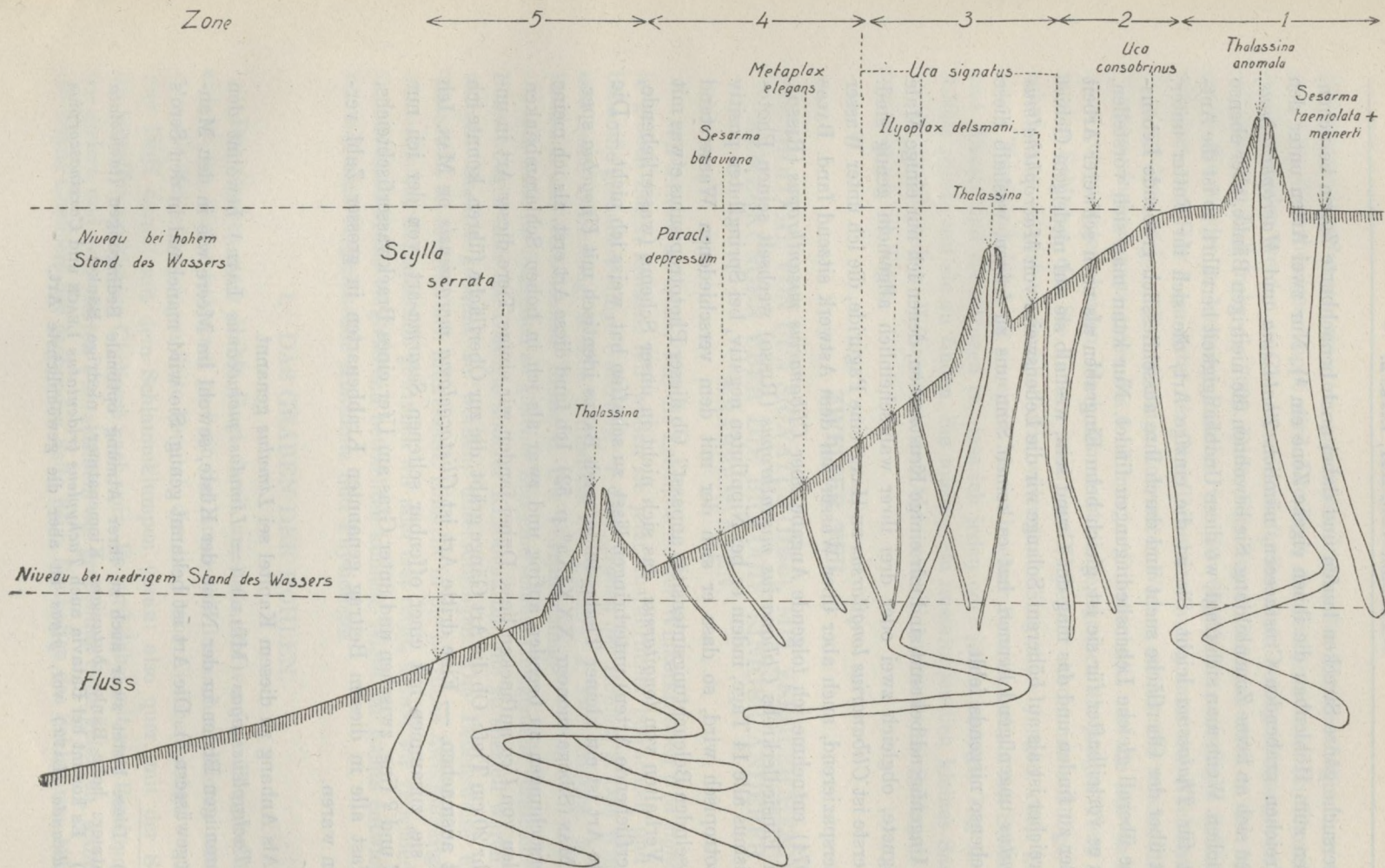


Fig. 3. Idealisierter Durchschnitt durch den Rand einer Schlammbank, mit Krabbenhöhlen und Zonenangabe.

Die Figur enthält einen Fehler, indem *Thalassina*-hügel nie auf dem Rand der Schlammbänke vorkommen, sondern nur auf dem horizontalen Teil. Ich habe hierdurch aber zeigen wollen, dass *Thalassina* den ganzen Schlammboden bewohnt, der in seiner Feuchtigkeit den Zonen I-V entspricht.



Futtersuche ganze Strecken laufen und dabei auch benachbarte Zonen besuchen, halten zum Höhlenbau die ihnen eigene Zone ein <sup>1)</sup>. Nur zwei Arten unter den zahlreichen grabenden Crustaceen, nämlich *Thalassina* und *Macrophthalmus*, stören sich an keine Zonenbildung. Sie bewohnen die niedrigen Bänke, aber ebenso die hohen. Wenn man sich fragt, wo diese Unabhängigkeit herrührt, so ist die Antwort für *Thalassina* leicht. Sie ist die einzige Art, die sich ihr Futter unter, statt über der Oberfläche sucht und durch ihre ausschliesslich grabende Lebensweise überall gleiche Lebensbedingungen findet. Nur kann man sich vorstellen, dass es vorteilhafter für sie ist, gleich beim Eingraben als nach schwerer Arbeit Futter zu finden und das mag der Grund sein, weshalb sie auf niedrigem Gebiet zahlreicher ist als auf höherem. Solange wir die Lebensweise von *Macrophthalmus definitus* ungenügend kennen, hat es keinen Sinn uns zu fragen, weshalb diese Art ebenso nirgends fehlt.

Ungenügend bekannt sind mir einige Krustazeeen, denen ich nur einige Male begegnete, obgleich zwei oder drei ihrer wahrscheinlich allgemein genug sind. Die erste ist *Clibanarius longitarsus* DE HAAN, eine Paguride, die ich unter Wasser umherspazierend, auch aber über Wasser auf dem Astwerk sitzend fand. BALLS (p. 974) entnehme ich folgende Angabe über *Clibanarius misanthropus* (Risso). „Der Einsiedlerkrebs *Clibanarius misanthropus* (Risso) wechselt seinen Phototropismus alle 14 Tage, indem er bei Nippfluten negativ, bei Springfluten positiv phototropisch wird, so dass er sich der mit dem verschiedenen Wasserstand wechselnden Beleuchtungsintensität anpasst“. Ob dieser Phototropismus etwas mit dem Verhalten von *longitarsus*, das sich nicht in unser Schema (wasserliebende, wasserfliehende Arten) unterbringen lässt, zu schaffen hat, weiss ich nicht. — Die zweite Art ist ein kleiner Thalassinide, nach BALLS identisch mit *Upogebia spec.* ♂ DE MAN (Siboga-monogr. XXXIXa<sup>6</sup>, p. 52). Ich fand diese Art erst, als ich meine Untersuchungen zu beenden anfang und zwar als ich in hohen Schlammhängen Höhlen von *Uca* aufhacken liess. Dabei fanden wir einige Tiere dieser Art in ungefähr 20 cm Tiefe. Ob die Art Gänge gräbt, die zur Oberfläche führen, konnte ich nicht ausmachen. — Eine dritte Art ist *Clistocoeloma merguensis* DE MAN. Ich fand sie, zusammen mit einer offenbar seltenen *Sesarma*-art, von der ich nur ein ♂ und ♀ fing, zwischen und unter Gras am Ufer eines Brackwasserfischteichs, wo fast alle in diesem Beitrag genannten Krabbenarten in grosser Zahl vertreten waren.

Als Anhang zu diesem Kapitel sei *Limulus* genannt.

*Tachypleus gigas* (MÜLL.) (= *Limulus moluccanus* LATR.) bewohnt den schlammigen Boden in der Nähe der Küste, sowohl im Meere wie in den Mangrovegewässern <sup>2)</sup>. Die Art ist bekannt genug. Sie wird manchmal in den Sero's

<sup>1)</sup> Diese bietet zwar auch zu ihrer Atmung optimale Bedingungen (*taeniolata* Luftatmer: hohe Bänke, *bataviana* Kiemenatmer: niedrige Bänke).

<sup>2)</sup> Es kommt bei Batavia auch *Tachypleus tridentatus* LEACH und *Carcinoscorpius rotundicauda* (LATR.) vor, *gigas* ist aber die gewöhnlichste Art.



(Fischreusen) gefangen, meistens paarweise, indem das kleinere Männchen vom grösseren Weibchen geschleppt wird. Die Eier, die sich ganz vorn im Thorakalschild befinden, werden an Chinesen verkauft; ihre Zahl betrug in einem von mir untersuchten Fall mehr als 7000. Diese Eier nun findet man auch in der Mangrove. Sie werden in lockeren Paketen von 50 - 60 Stück in sandigen Schlamm abgelegt, ungefähr 5 cm unter der Oberfläche, und wenig unter der Hochwasserlinie, so dass sie jedes Etmaal einige Zeit unter Wasser stehen. Sie werden durch Wasseraufnahme ganz gross, bis 6 - 7 mm im Durchschnitt und die Larven sind dann gut zu unterscheiden. Nach dem Auskriechen graben die jungen Tiere sich in den Schlamm ein. Sie können auch, mit Hilfe der Abdominalanhänge, gut schwimmen. Es ist unglaublich wie widerstandsfähig diese jungen, eben geborenen Tiere sind. Ich hielt sie einen Monat in einer Porzellanschale mit Schlamm und Wasser und sie ertrugen es, dass ich jeden oder jeden anderen Tag in der Schale rührte um sie zu finden. Sie müssen ein ausserordentlich kleines Sauerstoffbedürfnis haben. Während meiner Abwesenheit trocknete der Schlamm aus und starben die Tiere.

## ZWEITER TEIL.

### DIE BIOLOGIE VON *UCA SIGNATUS* (HESS), MIT VERGLEICHENDEN BEMERKUNGEN ÜBER DIE BIOLOGIE EINIGER ANDERER KRABBenARTEN.

Wir lernten im ersten Teil die Lebensweise der Winkerkrabben *Uca signatus* in groben Zügen kennen. Wir wollen sie jetzt ausführlicher betrachten und ich behandle gesondert einige Unterteile: 1. Das Graben der Höhlen, 2. Das Winken und seine Bedeutung, 3. Die Aufnahme des Futters, 4. Die Atmung, 5. Die Reaktion auf verschiedene Reize, 6. Die Fortpflanzung.

Ich habe im folgenden zu gleicher Zeit eine schöne Gelegenheit vergleichende Bemerkungen über die Biologie anderer Krabbenarten, die zu speziell waren, im vorigen Kapitel genannt zu werden, unterzubringen. Die Lebensweise einer Tierart ist an und für sich interessant. Einsicht in die herrliche Zweckmässigkeit der tierischen Organisation gewinnen wir aber erst recht, sobald wir verschiedene Organisationstypen vergleichend betrachten können. Nicht für nichts entwickelten sich eine vergleichende Anatomie und Physiologie.

#### 1. DAS GRABEN DER HÖHLEN.

Das Graben einer Höhle fängt damit an, dass drei vordere Thorakalfüsse sich in den Boden festsetzen und ein Schlammstück losmachen. Hierzu werden stets die Beine derjenigen Seite benutzt, die die kleine Chelicere trägt. — Das Tier läuft darauf mit dem Schlammklumpen voran; also quer, mit der Seite der betreffenden kleinen Chelicere nach vorn. Es wird dabei mit vier Pereiopoden der andern und dem vierten Thorakalbein der grabenden Seite gelaufen, während die kleine Chelicere der grabenden Seite beim Festhalten des Schlammes behilf-



lich ist. Bisweilen auch wird der Schlamm nur von der kleinen Chelicere und zwei, nicht drei, Thorakalfüssen getragen. Der Schlammklumpen wird in der Nähe der Höhlenöffnung deponiert, bisweilen aber ziemlich weit von dieser entfernt (ich mass bis zu 7 cm). Dieses Graben wurde genau von PEARSE (1914a, p. 417) beschrieben und durch einige Abbildungen illustriert (Fig. 4). — Das Graben wird fortgesetzt, bis das Grundwasser erreicht ist; der letzte Schlamm, der herausbefördert wird, ist also stets nass. Senkt sich der Wasserspiegel, so wird die Tiefe der Höhle entsprechend vergrößert. Die Höhle läuft senkrecht oder schief nach unten.

Während des Grabens und auch während des Aufenthaltes in den Höhlen werden die Augen oft mit Schlamm beschmutzt, auch klebt beim Männchen fast stets ein wenig Schlamm am grossen Chelipede. Beim Herauskommen der Tiere gibt es deshalb zwei ganz stereiotypische Bewegungen:

1. das Reinigen der Augen,
2. das Reinigen des grossen Chelipeds.

Das Reinigen der Augen findet statt durch den Endopodit des 3. Maxillipeds. Wie bei anderen Krabben ist dieser im terminalen Teil zwei Mal rechteckig gebogen:

Basi- und Meropodit begrenzen links und rechts den Eingang zum Mund (Fig. 7), senkrecht zu ihnen steht der Carpopodit, senkrecht darauf, und also parallel dem Basipodit, liegen Pro- und Dactylopodit. Letzterer trägt ein Bündel langer Haare. Solange die Tiere unten sind, liegen die Augenstiele in die Gruben niedergeklappt. Kommen sie nach oben, so wird der Endopodit ganz gestreckt, während die Augenstiele, die zur Aufklärung der Umgebung schon im Höhleneingang aufgerichtet wurden, in ihre Gruben zurückgeklappt und wieder aufgerichtet werden. Die Haare fegen jetzt über die Augen und Augenstiele bis diese schlammlos sind. BORRADAILE (p. 139) beschrieb die Bewegung für *Carcinus moenas*<sup>1)</sup>, WARD (1928, p. 246) für *Ocypode ceratophthalma*. Sie lässt sich an allen möglichen anderen Krabben beobachten, gilt für die Krabben im allgemeinen.

Die Reinigung des grossen Chelipeds beim Männchen ist nicht weniger Lebenssache. Die auffallende Farbe der Chelicere hängt zweifellos mit ihrer Funktion zusammen: das Drohinstrument und einzige Waffen. Die Reinigung der grossen Chelicere wird hauptsächlich durch die kleine Chelicere besorgt, die fortwährend damit beschäftigt ist, die angeklebten Schlammteilchen fortzunehmen. Wir werden später sehen, dass mit der kleinen Chelicere zugleich Zeit das

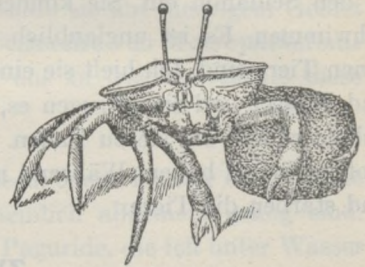


Fig. 4. *Uca* ♀, einen Schlammklumpen von der Höhle forttragend.

Nach PEARSE, 1912, aber Schlammklumpen geändert.

<sup>1)</sup> "They (die genannten 3. Maxillipede) brush the antennules, sometimes acting singly, sometimes combing an antennule between them. Each of them brushes the eye and antenna of its side, and reaches across to clean the mouth-parts of the opposite side, attending, for instance, to the delicate and probably sensory hairs of the expanded end of the endopodite of the first maxilliped."



Futter aufgenommen und zum Munde gebracht wird; hier tut sie das gleiche, nimmt nur das Futter nicht vom Boden, sondern von der Schere. — Gibt man den Tieren in der Gefangenschaft ziemlich trockenen, festen Schlamm, so trocknet dieser so schnell ein, dass es dem kleinen Cheliped nicht gelingt, den Schmutz fortzunehmen. Es ist nun höchst merkwürdig, zu sehen, wie dergleichen Tiere das Wasser aufsuchen und im Wasser merkwürdige, drehende Bewegungen machen: sie benetzen sich. Darauf setzen sie die Reinigung fort. In meinen Experimentierterrarien suchten die Tiere, solange die Höhle noch nicht fertig war, das Wasser auf, indem sie geradeaus zum Schlammabhang herunter liefen, um darauf wieder geradeaus nach oben zurückzukehren. Eben dieses Geradeauslaufen zeigt, dass das Wasser nur deshalb, zur Reinigung, aufgesucht wird; draussen werden die Tiere unter diesen Umständen also das Wasser am Rand der Schlammbank aufsuchen. — Sobald die Höhle aber fertig ist, braucht dieser gefährliche Spaziergang nicht mehr stattzufinden; wenn die Tiere sich benetzen wollen, so suchen sie den Boden ihrer Höhle (bisweilen auch einer andern Höhle) auf. Dass sie dabei wirklich das Wasser erreichen, geht daraus hervor, dass sie ganz nass zur Oberfläche zurückkehren. Dies gibt auch SYMONS schon für *Uca* an (p. 307). Wir werden später sehen, dass die Höhle, die eine schnelle Flucht ermöglicht, der feste Wohnsitz der Tiere ist. Obgleich die Winkerkrabben erst richtig aktiv werden, wenn eine brennende Sonne den schwarzen Schlamm Boden erhitzt, brauchen sie zu ihrem Wohlsein eine oftmalige Benetzung und zwar durch Wasser in ihrer unmittelbaren Nähe um keinen Feinden zum Opfer zu fallen. Wir verstehen jetzt weshalb die Höhlen das Grundwasser erreichen müssen.

Im Zusammenhang mit der grabenden Lebensweise dieser Tiere sind noch drei Gewohnheiten von Interesse: das Ebenen der Höhlenumgebung, das Bauen von Schornsteinen, und das Abschiessen der Höhlen. — Das Ebenen der Höhlenumgebung fiel mir besonders von gefangen gehaltenen Tieren auf, die eine unebene Schlammsschicht bewohnten. Sie bringen Schlamm, den sie sich in einiger Entfernung der Höhle holen, bis nahe an die Höhle heran, wodurch der Höhleneingang auf einer flachen Schlammsschicht zu liegen kommt. PEARSE (1914a, p. 419) beschreibt gleiches für andere *Uca*-arten, COWLES (1908, p. 7-8) für *Ocypode arenaria*. — Die kleinen Schornsteine, die bisweilen auf der Höhle stehen, die also den Höhleneingang nach aufwärts verlegen, können eine Höhe von einigen Zentimetern erreichen. Sie müssen dadurch entstehen, dass der ausgegrabene Schlamm nicht fortgetragen, sondern gleich um den Höhleneingang herum aufgetürmt wird. Die Wand des Schornsteins ist nur sehr dünn, man muss sich also vorstellen, dass er nicht aus einfach aufeinander gehäuften Schlammbrocken bestehen kann; ist dies richtig, so werden die Schornsteine speziell gebaut. Was ihre Bedeutung ist, weiss ich nicht; sie kommen sowohl auf feuchtem wie auf trockenem Land vor, und sowohl am Meer wie mehr landeinwärts. Auch in meinen Terrarien entstanden sie bisweilen, wodurch wir Gewissheit darüber haben, dass ein bestimmtes Tier das eine Mal gewöhnliche Höhlen, ein anderes Mal Schornsteinchen machen kann. Für weitere Angaben



über Schornsteinbau sehe man ORTMANN in BRONN, p. 1222 - 1223. — Das Abschliessen der Höhlen kann man sehr schön beobachten, wenn das Wasser während des Steigens über den Schlamm Boden herangekrochen kommt. Bevor es die Höhlen erreicht hat, setzen die betreffenden Tiere ihre drei vorderen Pereiopode (an der Seite der kleinen Chelicere) in den Schlamm und ziehen einen ziemlich grossen Schlammklumpen los, der darauf zum Höhleneingang getragen wird. Das Tier verschwindet in die Höhle und schliesst sein Gehäuse mit dem Schlammstück als Deckel ab. Es ist merkwürdig zu sehen wie die Grösse des Klumpens stets genau dem Höhleneingang entspricht. Die Oberseite des Schlammstückchens kommt dabei oben zu liegen, wodurch die Farbe des Deckels sich meistens nur wenig von der des umgebenden Schlammes abhebt. Die Tatsache, dass das Abschliessen der Höhlen besonders während des Steigens des Wassers stattfindet, mag zeigen, dass die Tiere sich vor Feinden schützen, die mit dem Wasser den Schlamm besuchen. Gleiches nimmt PEARSE (1914a, b) an, der weiter sagt (1914a, u. 416), dass "during a period of high tides burrows in low situations often remain closed for several days". Auch die folgende Tatsache weist daraufhin, dass die Abschliessung der Höhle den Schutz des Bewohners zum Zweck hat. Wenn man die Tiere beunruhigt, kann man nicht selten wahrnehmen, wie die in ihre Höhlen geflüchteten Tiere von innen aus die Höhle abschliessen. Sie kleben Schlammstückchen, welche sie der Innenwand der Höhle entnehmen, in den Eingang, bis dieser ganz oder nahezu ganz (eine kleine Öffnung kann in der Mitte sichtbar bleiben) verschlossen ist. Auch PEARSE (1914a, b) beschreibt das Abschliessen der Höhlen vor dem steigenden Wasser ausführlich. Er sagt, dass auf festem Schlamm ein einziges Schlammstück zur Abschliessung genügt, dass auf feuchtem Schlamm zwei oder drei „pellets“ herbeigetragen werden. Auch gibt er Abbildungen des Vorgangs. COWLES (1908, p. 8 - 9), der das Abschliessen der Höhlen für *Ocypode arenaria* beschreibt, sagt, dass es bei dieser Art, die die Gewohnheit hat, gefundenes Futter zur Höhle zu tragen, besonders stattfindet, nachdem die Krabbe Futter eingetragen hat. Bisweilen aber, „when individuals are disturbed by other crabs or by man, they will run into their burrows for a few inches and push a plug of sand up from below, completely closing the entrance“. PEARSE (1916, p. 554) beschreibt gleiches für *Cardisoma guanhumi* LATR. — COWLES (1915) hat für *Myctiris* (man sehe weiter unten) wahrscheinlich gemacht, dass Luft in der abgeschlossenen Höhle zurückbleibt, auch wenn das Wasser kommt. Deshalb nimmt SYMONS an, dass das Abschliessen der Höhlen bei *Dotilla* den Zweck hat, Luft in der Höhle aufzubewahren (siehe unten).

Das Öffnen der Höhlen geschieht, wie auch PEARSE (1914a, p. 418) schon bemerkt, von innen heraus, indem der Schlamm nach unten geschafft wird (an die Höhlenwand geklebt?). Der letzte Schlamm wird ohne weiteres zur Seite gedrückt, indem das Tier sich einfach herausringt. Die Schere liegt dabei anfangs fest gegen den Körper (vor den Mundteilen) gedrückt, wird darauf mit grosser Kraft vom Körper weggedrückt, oder der Körper wird von der Schere weggedrückt.



Der Hauptsache nach geschieht das Graben bei fast allen Krabben in der gleichen Weise. Sobald die Tiere im Stande sind, sich eigene Höhlen anzufertigen, zeigen sie den Instinkt die Füße als Grabwerkzeuge zu benutzen und die gewöhnliche Methode, der wir denn auch bei allen von mir untersuchten Arten begegnen, ist die, wobei die Füße einer Seite in den Schlamm gesetzt werden, um ein Schlammstück loszuziehen. Dabei wirken bei der einen Art die Chelipede mehr mit als bei der anderen. Ich nenne als mit den Füßen grabende Formen: die *Sesarma*-arten, *Metaplex*, *Paracleistostoma*, die *Uca*- und *Ocypode*-arten, *Cardisoma* (PEARSE, 1916, p. 554), wahrscheinlich *Dotilla*. Dabei benutzen die *Uca*-arten mit den kleinen Cheliceren diese nebenbei beim Graben, während *Cardisoma* (nach PEARSE), *Ilyoplax* und *Dotilla* einen ausgiebigen Gebrauch von den Scheren machen. *Ilyoplax* benutzt sie beim Verschliessen der Höhlen sogar als zwei kleine Schaufeln die den Schlamm zusammenfegen und als Decke auf den Höhleneingang deponieren. Auch *Cardisoma* kann die beiden Scheren in dieser Weise benutzen. PEARSE sagt: "Dirt while being carried from a burrow is trugged against the body by either chela and the walking leg next to it or held in both chelae, like a washerwoman carrying an armful of clothes". *Dotilla* benutzt sie zum blitzschnellen Verschwinden. Das Graben von *Ocypode arenaria*, das dem von *Uca* ähnlich ist, wurde beschrieben und abgebildet von COWLES. Einiges über die Ausführung der Höhlen von *Ocypode ceratophthalma* gibt WARD (1928, p. 246). Auch *Ocypode* gräbt nur mit der Seite des kleinen Chelipeds, mehr speziell trägt sie, wie *Uca*, den Sand mit dem Cheliped und den vorderen Thorakalfüssen der gleichen Seite. Es ist merkwürdig wie wenig der Bau dieser Krabben ihre grabende Lebensweise verrät.

Es würde zu weit führen hier grabende Crustaceen anderer Gruppen zum Vergleich heranzuziehen <sup>1)</sup>. Nur *Thalassina* sei in diesem Zusammenhang noch genannt. Sie ist mit ihren hakenförmigen Chelipeden ganz speziell zum Graben eingerichtet. Nachdem der Schlammklumpen wahrscheinlich mittels der grossen Chelipede losgehackt worden ist, wird er von den 2. Pereiopoden (die Chelipede als 1. Pereiopode gerechnet) getragen, während diese dabei einigermassen laufen. Oben wird der Schlamm von den Chelipeden, die über ihn herübergreifen, festgehalten, während ausserdem obenhinten noch die 3. Maxillipede das Schlammstück bedecken. Das Tier schob sich bei meinen Versuchen rückwärts (Schwanz vorn) aus der Höhle heraus. Draussen schoben die Chelipede, nachdem sie sich eingezogen und den Schlamm frei gegeben hatten, diesen vorwärts, wodurch die 2. Pereiopode entlastet wurden.

Die Höhlen von *Uca* gehen fast oder ganz geradeaus nach unten bis in das Grundwasser. Wo sie an tieferen Stellen liegen, brauchen sie weniger tief als auf höher liegendem Boden zu sein. Die Höhlen von *Ilyoplax* ähneln ihnen genau, haben nur einen kleineren Durchmesser. *Metaplex*, die auf niedrigem

<sup>1)</sup> Eine ganz interessante Crustaceengruppe in bezug auf das Graben, Rudern, u.s.w. (vgl. SCHELLENBERG, 1928) bieten die Amphipode, die, ihrem Bau entsprechend, wieder in ganz anderer Weise ihre Höhlen anfertigen. Die Orchestiden arbeiten den Sand, anstatt nach vorn, wie die bis jetzt besprochenen Tiere, nach hinten, genau wie wir das von grabenden Säugetieren kennen.



Schlamm die Höhlen gräbt, geht meistens schief nach unten, ebenso *Scylla*, die Höhlen von sehr grossem Durchmesser gräbt. Die Höhlen von *Sesarma* und auch die von *Thalassina* beschrieb ich schon, sie gehen im allgemeinen senkrecht oder schief nach unten und es mag sein, dass sie ab und zu einen Seitengang besitzen.

SYMONS beschrieb die Höhlen von *Dotilla*. Er gibt an, dass auf trockenem Sand tiefe Höhlen gemacht, dass aber auf ganz feuchtem Gebiet keine Höhlen angefertigt werden, da die Tiere da bei der Annäherung eines Feindes sich blitzschnell eingraben. Er gibt weiter an, dass *Dotilla*, wenn das Wasser steigt, sich in kleine Höhlen eingräbt, die oben abgeschlossen werden und also Luft enthalten. Diese Höhlen scheinen die gleichen zu sein als die, welche von COWLES (1915) für *Myctiris longicarpus* LATR. beschrieben wurden.

"In the wet sand a small cavity about three-quarters of an inch in diameter is excavated in the shape of a cup. Then the crab, standing in the middle, starts to carry wet lumps of sand from the bottom and piles them on to the sides. Working very rapidly, he soon (that is, in 2 or 3 minutes) has a complete wet-sand chamber enclosed and roofed in, the air inside being retained by the wet-sand. I watched one do this, waited for a few minutes, and then dug down at the spot and found that the crab and the air chamber had disappeared quite deep into the sand. Presumably, although it is impossible to see this part of the process when the chamber is completely roofed in, the crab goes on working in the same way until the air bubble or chamber is carried down to the requisite depth, so that the tide overhead will not disturb it. In this air chamber the crab remains until the tide has gone down and he can come up again to feed" (SYMONS, p. 311 - 312).

Es scheint, dass die Annahme, die Krabben nehmen sozusagen Luft mit nach unten, eigentlich von COWLES herrührt. Nach ihm lebt *Myctiris* "only at a considerable distance seaward from the high-tide mark on exposed sand flats". Nähert man sich ihnen, so verschwinden sie im Nu in den feuchten Sand.

"Almost simultaneously each individual ceases feeding and begins to dig with the legs of one side at the same time rotating so that the digging follows a spiral. The result is that a circular mound covering the crab is soon thrown up which usually has a small hole in the center of it, but this hole is quickly closed by wet sand pushed up from below (Plate III, figs. 1 to 3). As all of this is done within two or three seconds, it is evident that they work very rapidly. The individuals of a group of feeding crabs are usually packed together so that they touch one another, and since they dig down where they are when they stop feeding the circular mounds interfere with one another, producing a large patch of disturbed sand in which the individual mounds are almost indistinguishable (Plate II, fig. 2). These patches of turned up sand are often very conspicuous when surrounded by the smooth surface of sand left by the receding tide".

"I was unable to determine whether or not this cavity filled with air really remains in the natural habitat after the tide has risen and covered the sand flat, but judging from the results obtained in attempting to reproduce such a condition in the laboratory it seems possible. Several specimens of *Myctiris* were placed in a receptacle half-filled with wet sand taken from the sand flats. After they had dug down and had been allowed enough time to make cavities, the receptacle was filled with water. Later in the day I dug down in the sand at a place where a crab was supposed to be and in so doing released the crab and a large bubble of air.



The latter undoubtedly filled the cavity occupied by the myctiris and was held in place by the firmly packed sand surrounded on all sides by water."

Die Höhlen von *Ocypode arenaria* wurden von COWLES (1908, p. 4-9) ausführlich beschrieben. Die gewöhnlichen Höhlen haben nach ihm einen Seitengang, der ganz nahe der Oberfläche blind endet und nur der Flucht zu dienen scheint. Bei den von mir untersuchten Höhlen dieser Art fand ich diesen Seitengang niemals <sup>1)</sup>. Für weitere Angaben über Höhlenbau sehe man die Schilderungen ORTMANNs in BRONN (p. 1219 - 1223).

## 2. DAS WINKEN UND SEINE BEDEUTUNG.

Nur die Männchen winken. Und zwar gibt uns das Winken folgendes zu sehen. Das Tier sitzt vor oder in nächster Nähe seiner Höhle und hält dabei — wie stets — den grossen Cheliped vor dem Mund. Dabei steht der Cheliped ein wenig „geöffnet“, d.h. das Endstück des Propodits und der Dactylopodit berühren

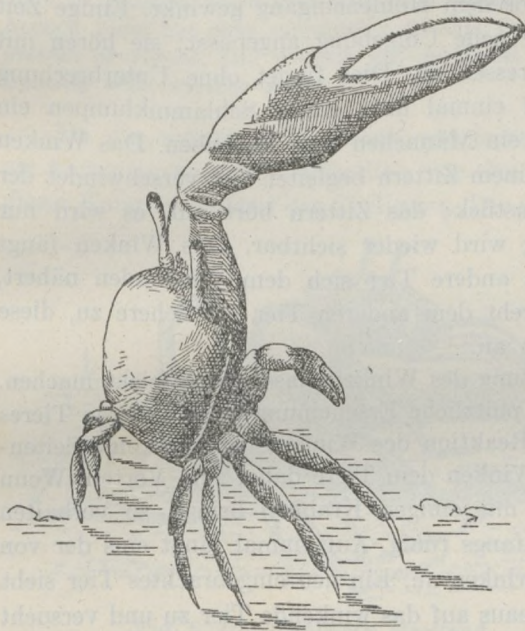


Fig. 5. *Uca pugilator* ♂, winkend.  
Nach PEARSE, 1914a.

sich nicht. Die Krabbe hebt sich jetzt — aber nur für ganz kurze Zeit — auf den Meropoditen der Pereiopode kaum merkbar in die Höhe, wodurch der ganze Körper schwach aufwippt. Dabei wirkt das Carpopropodit-gelenk und der Meropodit kommt statt horizontal oder etwas schief nach unten (proximales Ende unten) schief nach oben, resp. horizontal zu stehen. Zugleich wird der Meropodit, aber besonders der Carpopodit des grossen Chelipeds etwas nach oben bewegt. Hierbei wirken zwei Gelenke, welche eine Bewegung der Schere (Pro- und Dactylopodit) nach oben und aussen zur Folge haben. Das Carpopropodit-gelenk wirkt dabei als Regel

offenbar nicht. Die Schere bleibt während des Winkens „geöffnet“. — Wir sehen also beim Winken als Hauptsache ein nach oben und etwas nach aussen Bewegen der weissen Schere, begleitet von einem Auf- und Niederwippen des ganzen Körpers; letztere Bewegung kann fehlen. Es sei noch hinzugefügt, dass die winkenden Tiere bei grosser Erregung zittern können, wie ich das für

<sup>1)</sup> Ich grub viele *Ocypode ceratophthalma* auf der kleinen Koralleninsel Dapur aus. Alle Höhlen gingen schief, vom Meer abwärts, oder fast senkrecht, nach unten, um dann nach rechts oder links (dem Meere zu) umzubiegen und blind zu enden. Einen Seitengang gab es in keiner der vielleicht 40 ausgegrabenen Höhlen.



*Ilyoplax delsmanni* und für *Sesarma* beschrieb; die grosse Chelicere wird dabei schnell bewegt. Obgleich die Weibchen nicht winken, zeigen auch sie ein Zittern, ähnlich dem der Männchen. — Abbildungen winkender Tiere gibt PEARSE (vgl. Fig. 5).

Ich sagte schon dass das Winken eine Territoriumbegrenzung bedeutet. Es besagt „Hier ist ein Mann, hütet euch ihn nicht zu hindern!“ Wir dürfen das Winken in dieser Beziehung vergleichen mit dem Gesang der Singvögel; auch dieser hat in erster Linie die Bedeutung, das Brutgebiet indirekt gegen andere Männchen zu behaupten.

Bringt man die frisch gefangenen Tiere in ein Schlammterrarium, so laufen sie alle umher, streiten sich und fallen über einander her, keines winkt aber. Nach einiger Zeit fangen sie an sich einzugraben. Sobald sie sich aber einen Platz gewählt haben, ist ein Territorium entstanden. Sind sie also mit dem Graben mehr oder weniger fertig, und kommen sie jetzt mit oder ohne Schlammklumpen heraus, so wird in oder vor dem Höhleneingang gewinkt. Einige Zeit später haben die Tiere sich an die neue Umgebung angepasst; sie hören mit dem Winken auf und fangen zu fressen an. Dies findet ohne Unterbrechung einige Minuten lang statt, bis auf einmal über einem Schlammklumpen ein anderes Tier sichtbar wird, sei dies ein Männchen oder Weibchen. Das Winken fängt aufs neue an und wird vom einem Zittern begleitet. Da verschwindet der Eindringling hinter einem Schlammstück; das Zittern hört auf, es wird nur schwach gewinkt. Der Eindringling wird wieder sichtbar. Das Winken fängt aufs neue kräftig an. Je mehr das andere Tier sich dem Winkenden nähert, desto aufgeregter wird dieses, es dreht dem anderen Tier die Schere zu, diese wird ausgeklappt, der Kampf fängt an.

Beobachtungen über die Bedeutung des Winkens lassen sich leicht machen. Denn der geschilderte Vorgang: die plötzliche Erscheinung eines anderen Tieres und die damit zusammenhängende Reaktion des Winkens ist gar keine Seltenheit. Nicht stets aber gereicht das Winken dem Tiere dabei zum Vorteil. Wenn man neue Tiere in ein Terrarium mit einigen Krabben bringt, so verhalten die neu eingebrachten Tiere sich anfangs ruhig. Auf einmal fängt eins der von unten heraufgekommenen Tiere zu winken an. Ein neu eingebrachtes Tier sieht es und wird aktiv; es spaziert geradeaus auf das winkende Tier zu und versucht sich in dessen Höhle einzudringen. Ist das Tier stärker als der Einwohner, so flüchtet dieser sich nach längerer oder kürzerer Zeit und hat damit seine Höhle verloren. Es ist interessant dass der Eindringling weiss: wo gewinkt wird, gibt es eine Höhle. — Wie ich schon bemerkte und auch später noch sagen werde, wird sowohl gegen Männchen wie gegen Weibchen gewinkt, wenn sie sich der Höhle nähern. Das Winken ist aber weder „Demonstration“ den Weibchen gegenüber, wie man oft angegeben findet, noch etwas anderes, es wird ausschliesslich zur Andeutung der Gebietsgrenzen benutzt.

Dass das Winken die Bedeutung haben würde, stimulierend auf die Weibchen zu wirken, ist wohl am ausführlichsten von PEARSE (1914a und b) behauptet worden. PEARSE gibt eine Beschreibung von der Weise, wie die Männchen die Weibchen an-



zuziehen versuchen und er gibt Abbildungen winkender Männchen. Aber ich kann aus seinen Beschreibungen und Abbildungen nur schliessen, dass er Männchen hat winken sehen, und weiter, dass ich das Benehmen der Männchen den Weibchen gegenüber, wie er das beschreibt, ganz anders interpretieren würde als er. Wie schon gesagt sah ich nie etwas, das auf einen Zusammenhang zwischen Winken und Paarbildung hingedeutet hätte. — Auch das Spiel, das PEARSE (1914a, p. 422) beschreibt, sieht so vermenschlicht aus, dass ich nicht daran zweifeln kann, hier mit anthropozentrischer Interpretation zu tun zu haben. Soviel ich weiss, kommt ein „Spielen“, wie es hier beschrieben wird, nur bei Säugetieren, höchstens auch bei Vögeln vor. Es fragt sich sogar ob der Gesichtssinn von *Uca* mit seinem gewiss mangelnden Formensehen ein Spiel, wie es beschrieben wird, ermöglicht.

Es kommt hinzu, dass PEARSE, in seinem Beitrag von 1912, p. 128, dem ausführlichsten und genauesten der drei, sich viel weniger positiv über diesen Punkt auslässt. Er beschreibt da das Verhalten der Geschlechter „during courtship“, schliesst aber mit Bemerkungen gegen ALCOCK (1892). „It would be easy for anyone observing the crabs in a casual way to believe that the males were trying to attract the females by their bright colors, but the writer saw nothing in the behavior of either sex that could be interpreted in that way. The males often wave their claws frantically, as ALCOCK says, but they apparently do this to an equal extent whether females are present or absent, and without any apparent reference to mating but often before fighting with another male“.

Da die wehrlosen Weibchen vor jedem sich nähernden Tier fliehen und nie kämpfen, wird ausschliesslich von den Männchen gekämpft und zwar ist dieser Kampf ein Streit der Cheliceren. Die geöffneten Scheren der beiden Gegner

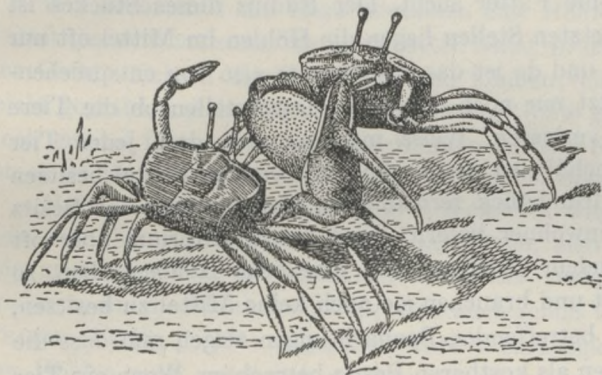


Fig. 6. *Uca*-männchen streitend.  
Nach PEARSE, 1912.

greifen in einander und versuchen, sich zu schliessen; man hört deshalb ein merkwürdiges Knattern. PEARSE (1914a und b) gab hiervon ganz gute Abbildungen und beschreibt das Kämpfen (1914a, p. 421, vgl. Fig. 6).

Zum Kampf kommt es, wo so viele Tiere auf kleinem Gebiet zusammen vorkommen, natürlich oft genug. Andererseits wird

das Winken respektiert. Und auch da, wo es nicht genügend respektiert wird, braucht es deshalb noch nicht zum Kampf zu kommen. Wenn zwei Tiere sich einander nähern, so wird die Chelicer, die während des Winkens horizontal getragen wird, nach aussen geschlagen, wodurch Pro- und Carpopodit fast senkrecht zu einander stehen; die Schere weist also vom Körper fort; dabei ist die Schere geöffnet. Wir kriegen jetzt, je nach der Urgenz des Falles, verschiedene Möglichkeiten: 1. das Tier setzt das Winken fort, schlägt aber ab und zu die Schere nach aussen, 2. die Schere wird fortwährend ein- und ausgeschlagen, 3. die Schere weist unausgesetzt nach vorn und die geöffnete Schere



begegnet der Schere des Partners. Diese Drohhaltung: das Auswärtsweisen der geöffneten Schere, ist nicht nur für *Uca* charakteristisch, sie ist die gewöhnliche Drohhaltung der Brachyura.

Die Tiere, die sich in ihre Höhlen zurückziehen oder die aus ihren Höhlen hervorkommen, können das tun mit der Schere nach oben oder nach unten. Geht aber ein Tier in eine ihm unbekannte Höhle hinein, so weist die Schere nach unten und kommt ein Tier aus der Höhle hervor wenn ein Feind in der Nähe ist, so weist die Schere nach oben. Bisweilen versucht ein Tier ein anderes Tier in einer Höhle mit der Schere zu greifen; es führt dazu die geöffnete Schere in die Höhle hinein und versucht dann selbst der Schere zu folgen. Da aber die Schere in dem schmalen oberen Teil der Höhle nicht aus- oder eingeklappt werden kann, muss das Tier erst wieder zum Höhlenausgang heraus um die Schere zuzuschlagen! Umgekehrt flüchtet sich das Tier, dem nachgesetzt wird, in die Höhle hinein, indem die ausgeklappte Schere nach oben weist. Auch dieses Tier muss zur Höhle hinaus um die Schere zuzuschlagen. SYMONS gibt von einem solchen Tier eine Abbildung.

Wir können nach dem gesagten nicht daran zweifeln dass das Winken die Bedeutung hat anderen mitzuteilen wo es eine Höhle gibt. Man fragt sich weshalb dies für die winkenden Tiere so wichtig ist. Um diese Frage beantworten zu können, müssen wir die Tiere draussen bei der Futtersuche studieren. Wir sehen dann dass sich jedes Tier, wie weiter unten ausführlicher besprochen wird, in der direkten Umgebung seiner Höhle Futter sucht. Der Radius dieses Stückes ist verschieden gross, an dicht besetzten Stellen liegen die Höhlen im Mittel oft nur 1 - 2 dm von einander entfernt und da ist das Territorium also von entsprechender Grösse. Es kommt also jetzt nur noch darauf an festzustellen ob die Tiere nicht oft ihr kleines Gebiet verlassen. Weiss man nämlich dass jedes Tier ein bestimmtes Territorium innehält, so weiss man auch dass es Mittel besitzen muss, Nachbarn von diesem Grundstück fernzuhalten; sonst würde der Besitz ungenügend Futter für den Einwohner liefern. Wird das Territorium aber oft für ein anderes verwechselt, indem die Tiere sich eine neue Höhle graben, so leiden die Tiere keine Futternot und brauchen sie auch keine Mittel zu besitzen, Eindringlingen zu wehren. Die betreffenden Beobachtungen zeigen nun dass die Tiere im allgemeinen ihre Höhlen als kostbaren Besitz betrachten. Wenn ein Tier sich bei der Futtersuche einmal weit von der Höhle entfernt und dabei überrascht wird, so kann es vorkommen, dass es die Höhle nicht zurückfindet. Ein solches Tier läuft dann weiter, sucht bei herannahender Gefahr andere Höhlen auf und siedelt sich schliesslich in einer fremden Höhle an. Es wird diesenfalls bestimmt eher eine andere Höhle gestohlen als eine neue Höhle gegraben. Letzteres ist eine zeitraubende, ziemlich schwere Arbeit, ersteres ist bisweilen leicht.

PEARSE (1914a, p. 419) gibt in dieser Richtung die folgenden Beobachtungen (ausführlichere Notizen gibt er in dem Beitrag von 1912). "A fiddler usually does not wander more than a meter or two from his hole, and is ever ready to dart into it at the slightest provocation. Occasionally, however, a crab roves as much



as 12 meters from his home and returns. Once in the Philippines a *Uca marionis nitida* left its burrow and dug a new one 4.5 meters away; another individual moved his dwelling place 2.4 meters; but such cases were unusual. Most crabs showed a strong preference for a particular locality".

"A number of crabs were snared and moved various distances from their holes to see if they would return. If the space was less than 2 meters they usually came back at once. At greater distances some crabs dug new holes and reestablished themselves, even though they were in plain sight of their old homes; others tried to return home and were not able to do so." "Notwithstanding the difficulties, however, some crabs returned after several days to the hole they had previously occupied. One individual was moved 6 meters, and returned after 23 days to within 30 centimeters of his old home, which had been filled up by the tides in the meantime".

Es ist schade dass der Autor, durch die Wiedergabe von Tagebuchnotizen, keinen Einblick in seine Beobachtungen ermöglicht hat. Ein Areal mit einem Durchmesser von 4 Meter hat wohl keine der von mir gesehenen Winkerkrabben. Eher handelt es sich hier um Dezimeter. Weiter ist es natürlich sehr wohl möglich dass einige Krabben nach mehreren Tagen zur eigenen Höhle zurückkehrten, allein hier dürfen wir ruhig annehmen, dass dies in soweit Zufall war, dass die Tiere von einer Höhle zur andern zogen, bis sie sich zuletzt zufällig in dem alten bekannten Gebiet wiederfanden. Wir haben also mit einem Ortskenntnis wie bei *Sesarma*, nur auf kleinerem Gebiet, zu tun, wie denn auch PEARSE richtig von "Place association" spricht. Ob diese aber so lange beibehalten wird, dass eine Krabbe dadurch nach 23 Tagen ihre alte Umgebung wiederfand, müssen ausführlichere Beobachtungen uns sagen. Wir können vorläufig vielleicht ebensogut annehmen dass es sich hier um einen blossen Zufall handelte.

Wir sehen also: die Tiere bewohnen eine Höhle; um die Höhle herum wird Futter gesucht, meistens nur in nächster Nahe, so dass die Tiere bei herannahender Gefahr sich in die Höhle flüchten können; eine andere Höhle wird nicht leicht gegraben, eher wird eine benachbarte Höhle gestohlen. Wenn wir uns jetzt noch einmal fragen, weshalb das Winken für die betreffenden Tiere so wichtig ist, so ist die Antwort leicht. *Andere Tiere sollen wissen dass der Boden besetzt ist.*

Nur die Männchen winken. Die Weibchen winken nicht. Es ist auffallend dass sie, obgleich sie auch Höhlen bewohnen, also vor Feinden geschützt sind (sie graben selbst), die Höhlen viel leichter verlassen und viel mehr umher-spazieren als die Männchen. Dies wird auch schon von SYMONS (p. 307) und von PEARSE (1914b, p. 795) angegeben. Ihre Wehrlosigkeit würde eine Verteidigung der Höhlen auch unmöglich machen. Es mag sein dass das Umher-spazieren der Weibchen für die Art ein Vorteil ist, da geschlechtsreife Weibchen in dieser Weise leicht von den Männchen gefunden werden. — Die Männchen schienen mir gegen Weibchen bisweilen weniger aggressiv als gegen andere Männchen; dadurch mag den Weibchen die Futtersuche auf fremdem Gebiet nicht ganz und gar zur Unmöglichkeit werden.

Das Winken finden wir, ausser bei den *Uca*-arten, bei einigen anderen Krabben. Ich beschrieb es schon für *Ilyoplax delsmanni*, die aber mit zwei Scheren winkt. Auch hier finden wir das Sich-aufheben auf die Beine. Dass wir mit einer für beide Krabben-arten verwandten Erscheinung zu tun haben, könnte man daraus schliessen, dass *Ilyoplax* sogar das Zittern von *Uca* zeigt. Wir



finden das Zittern aber auch bei *Sesarma (cumolpe)*. — Weiter winkt nach WARD (1928, p. 243) die Semaphore Krabbe, *Heloecius cordiformis*, und zwar auch sie mit beiden Scheren; WARD beschreibt das Winken deutlich. Eine weitere winkende Krabbenart, vermutlich *Tetralia glaberrima* (HERBST), beobachtete ich in Tjilatjap; auch diese winkt mit beiden Chelipeden.

Man fragt sich unwillkürlich weshalb wir das Winken bei einigen Arten finden, während es anderen Arten mit ähnlicher Lebensweise fehlt. Eine teleologische Betrachtungsweise mag ihre Nachteile haben, sie bietet uns den Vorteil, uns die Möglichkeit einer besseren Einsicht zu geben als die blosser Feststellung der Tatsachen. Soweit sich ersehen lässt, finden wir das Winken nur bei Arten, die in grosser Zahl dicht beisammen wohnen, dabei an eine bestimmte Höhle gebunden sind und um den Höhleneingang herum den Boden fressen. Unter den landbewohnenden Krabben kommen, obgleich sie äusserst zahlreich sein können, die Gecarciniden und die Sesarmiden schon deshalb nicht in Betracht, da sie Konsumenten gröberen Materials sind und auf grösserem Areal ihr Futter suchen <sup>1)</sup>. Unter den richtigen Schlammfressern finden wir aber einige Arten, die das Winken haben „sollten“, denen es aber fehlt. Ich denke hier unter den von mir beobachteten Krabben an erster Stelle an *Metaplex* und *Paracleistostoma*, an zweiter Stelle an die kleinen *Dotilla*, *Scopimera* und an *Myctiris*. Was nun letztere Arten anbelangt, so geben diese ein Beispiel der oben besprochenen zweiten Möglichkeit: weil sie blitzschnelle Gräber sind, hat ihre Höhle nur einen geringen Wert für sie. Sie brauchen also vielleicht keine Nachbarn fernzuhalten, da an die Stelle des Winkens das blitzschnelle Graben treten mag. *Metaplex* und *Paracleistostoma* indessen ähneln in ihrer Futterabhängigkeit in jeder Hinsicht den winkenden Krabbenarten, dennoch winken diese Tiere nicht. Hoffentlich wirken spätere Studien hier aufklärend.

### 3. DIE AUFNAHME DER NAHRUNG.

Wie gesagt sind die Mangrovetiere besonders deswegen interessant, weil es unter ihnen eine so grosse Zahl reiner Schlammfresser gibt. Unter ihnen ist *Uca* einer der typischsten. Bevor wir uns aber die Futteraufnahme selbst ansehen, müssen wir uns fragen, wo diese unendliche Nahrungsmenge denn eigentlich herrührt.

Jeden Tag bedeckt das Meerwasser während der Stunden des Hochwassers den Boden. Es sieht in der Nähe der Mangroveküste braunrot bis braungrau

<sup>1)</sup> WARD gibt für *O. ceratophthalma* an, dass sie bisweilen winkt. Es würde wichtig sein, diese Angabe, die nicht dokumentiert wird, bestätigt zu haben. Für einige dieser grabenden Krabben spielt zwar nicht die Verteidigung des ganzen Gebiets, sondern die Behauptung der Höhle, eine wichtige Rolle. Man sehe die Beschreibung der Lebensweise von *Ocypode arenaria* von COWLES (1908, p. 6). Es scheint nicht unmöglich, dass der Laut, den *O. ceratophthalma* macht und der einem Knurren ähnelt, zur Warnung des Feindes dient und also in der Höhle an die Stelle des Winkens tritt. ALCOCK (WARD, p. 246) „found that by forcing one crab to enter another's burrow, he caused the occupant to give vent to its annoyance in loud grating“.



aus, durch den Schmutz <sup>1)</sup>, der von den betreffenden Flüssen ins Meer geführt wird. Die den Schmutz bildenden ganz feinen Schlammpartikelchen werden vom Wasser mit über die Schlammflächen geführt und da das Wasser hier einige Zeit ruhig steht, wird ein Teil des Schlammes zu Boden sinken. Zieht das Wasser sich zurück, so bleibt dieser Teil auf dem Boden zurück. — Woraus besteht dieser Schlamm? Aus feinen Sandkörnchen, Resten tierischen und pflanzlichen Ursprunges, aus Fisch- und andern Eiern, lebenden Protozoen, Larven niederer Tiere, Algen, in Verwesung begriffenen Teilen höherer Pflanzen, u.s.w. Bleiben diese organischen Reste zurück, so werden sie einen Nährboden bilden für zahlreiche Organismen, für die der Salzgehalt kein Hindernis ist. Es entsteht ein „Schlamm“, der eine Welt für sich bildet, in dem die faulenden Produkte den Hauptbestandteil bilden. Dieses in sich merkwürdige Milieu zahlreicher Bakterien, Diatomeen, u.s.w. wird nun, als ganzes, gefressen. Der Schlamm darf dabei aber eine gewisse Trocken- oder Feuchtigkeit nicht überschreiten. Wie gesagt liegt in den Anforderungen, die die Tiere an den Schlamm stellen, zweifellos die Ursache für das Zustandekommen der Zonen.

Das Fressen findet mit der kleinen Chelicere statt, beim Männchen geschieht es also mit einer, beim Weibchen mit beiden Scherenfüssen. PEARSE (1914a, p. 429) wies darauf hin, dass die Cheliceren „are flattened and hollowed in such a way that they form admirable dredges for carrying mud to the mouth“. Indem das fressende Tier langsam vorwärtsschreitet, bewegt sich der kleine Cheliped schnell hin und her vom Boden zum Mund. Fast ohne Auswahl wird die ganz oberflächliche Schicht des Bodens fortgefressen, und zwar nur diese. Es geschieht so schnell dass es nur mit grosser Mühe und einer Lupe gelingt, den Schlamm in der Chelicere zu sehen.

Ich sage, der Schlamm wird zum Munde geführt. Mehr als dieses können wir anfangs nicht feststellen und ich muss sagen dass es mir grosse Mühe machte richtig zu sehen, was dabei stattfindet. Es kommt kurz auf das folgende nieder. Sobald das Tier zu fressen anfängt, werden die Basalstücke der dritten (äusseren) Maxillipede, die besonders dazu dienen, die zarten Mundgliedmassen vor Schädigung zu schützen, „geöffnet“. Ich benutze diesen Ausdruck, weil sich die beiden Basalstücke (hauptsächlich die Ischio- und Basipodite), wie die beiden Hälften einer Doppeltür, nach aussen drehen (Fig. 7). Da aber die Terminalteile, also Carpo-, Pro- und Dactylopodit, sich nicht mitdrehen, sondern ihren ursprünglichen Stand behaupten, stehen diese oben vor den übrigen Mundgliedmassen, indem die langen Borsten der Dactylopodite, die ich Terminalborsten nenne, nach unten gerichtet sind. Bei genauem Zusehen kann man nun beobachten wie jedesmal, wenn eine Chelicere Futter herbeibringt, die Terminalstücke der 3. Maxillipede sich etwas heben und ausserdem dem Futter entweichen. Übergibt die linke Chelicere Futter, so bewegen die Terminalstücke sich etwas nach rechts, und umgekehrt. Ausserdem glaubte ich dann und wann zu sehen, wie die Terminalborsten dabei über (vor, statt hinter) die Chelicere gehoben

<sup>1)</sup> Die rote Farbe rührt vom roten Boden Javas her, der aus dem tonigen Laterit besteht.



wurden. Wenn dies zutrifft, so würde sich daraus ergeben, dass die Terminalborsten, während die Cheliceren den Schlamm den Mundteilen übergeben, sozusagen bei der Reinigung der Cheliceren behilflich sind. Dass dem wirklich so ist, geht daraus hervor, dass die Reinigung des kleinen Chelipeds (das heisst das Entfernen angeklebter Schlammteilchen) ebenso von den Palpen (Terminalteilen) der 3. Maxillipede ausgeführt wird. Wir wissen schon (vgl. Seite 200), dass die Augenstiele durch die genannten Borsten gereinigt, indem die Terminalstücke der 3. Maxillipede gestreckt werden. Weiter wissen wir dass die grosse Chelicere des Männchens von der kleinen Chelicere gereinigt wird. Jetzt sehen wir dass die kleine Chelicere wiederum von den genannten Terminalborsten gereinigt wird. Was aber tun die Terminalborsten mit dem Schlamm? Wenn wir jetzt sehen, dass diese Borsten offenbar eine Rolle bei der Futteraufnahme spielen, da verstehen wir, dass der „Schmutz“ der Augen und Scheren gegessen werden kann, alsob es die gewöhnliche Nahrung wäre. Das stimmt mit der Angabe BORRADAILES, vgl. Fussnote Seite 200, dass die Palpen der 3. Maxillipede die Mundteile der gegenüberliegenden Seite reinigen.

Die geringe Grösse der hier studierten Tiere macht die Untersuchung sehr schwierig. Besonders die grosse Menge nassen Schlammes entzieht bei *Uca* die Mundteile der Beobachtung. Gerade deshalb mag es von Interesse sein hier kurz die Funktion der Mundgliedmassen einer grösseren Krabbenart, in soweit sie besser bekannt ist, zu besprechen.

Das „Öffnen“ der Basalstücke der 3. Maxillipede kommt bei allen Krabbenarten vor, deren 3. Maxillipede die übrigen Mundgliedmassen völlig bedecken, nicht nur bei der Futteraufnahme, sondern ausserdem bei der Atmung (man sehe weiter unten). Man bekommt den Eindruck dass bei diesen Arten die genannten Basalstücke, zusammen aber mit den Palpen, an erster Stelle dazu dienen, die übrigen Mundgliedmassen vor Schädigung zu schützen. BORRADAILE (p. 138) bemerkt gleiches für *Carcinus*. Andererseits gibt es aber eine Anzahl Arten, bei denen diese Gliedmassen gar nicht als Operculum fungieren. — BORRADAILE nimmt weiter an, dass gerade das Operculum die Wirkung des Scaphognathits so effektiv macht. „The current set up by the scaphognathite is a wonderfully strong one, partly because it is working in a closed system of passages, and there are several places in the neighbourhood of the inner mouth-parts where leakage is probably liable to take place, and throws unnecessary work upon the scaphognathite in keeping up a current of the swiftness which is needed. The closing of the operculum prevents this“. Ich mache aber nochmals darauf aufmerksam, es bestehen viele Krabben deren 3. Maxillipede nicht den Mund abschliessen.

Beobachtet man eine grössere Krabbenart, zum Beispiel die Schwimmkrabbe *Neptunus pelagicus* (L.), bei der Verarbeitung eines grösseren Fleischstücks, so ist leicht feststellbar, dass das Festgreifen der Nahrung, ausser von den grossen Cheliceren, an erster Stelle von den 3. Maxillipeden besorgt wird. Verliert eine Krabbe die Chelipede, so treten die 3. Maxillipede an ihre Stelle; die Krabbe senkt den Vorderkörper und die 3. Maxillipede greifen die Nahrung auf <sup>1)</sup>. Unter normalen Ver-

<sup>1)</sup> Füttert man grosse Krabben, wie *Neptunus pelagicus* oder *Scylla serrata*, wie das jeden Tag im publiken Aquarium unseres Laboratoriums geschieht, mit kleinen Tieren, z. B. *Mysis*, so ist interessant zu sehen, dass sie die grossen Scheren fast oder gar nicht zur Futteraufnahme benutzen, sondern das Futter fast ausschliesslich mittelst der 3. Maxillipede aufnehmen. Dabei wird der Vorderkörper gesenkt, um mit den Maxillipeden den Boden erreichen zu können.



hältnissen schieben die Terminalstücke der Endopodite (Palpen) das dargereichte Fleisch zwischen die beiderseitigen Ischiopodite. Dies wird von BORRADAILE ausführlich für *Carcinus* beschrieben. Die Cheliceren und 3. Maxillipede schieben darauf das Futter hinein, wobei es, zwischen den beiderseitigen 2. Maxillipeden hindurch, zwischen die Mandibeln gerät. Letztere ziehen nun Stückchen vom Fleisch los, indem die Cheliceren und Maxillipede jedesmal den Brocken kräftig nach aussen ziehen, während er von den Mandibeln festgehalten wird <sup>1)</sup>. Darauf öffnen sich die Mandibeln und Chelipede und Maxillipede schieben das Fleischstück wieder nach innen, worauf die Mandibeln sich wieder schliessen und die Maxillipede und Cheliceren das Fleisch auswärts ziehen. Die Hauptarbeit des Festgreifens und Ziehens wird einerseits von den Mandibeln, andererseits von den Ischiopoditen der 3. Maxillipede vollführt. Die 2. Maxillipede helfen zwar mit (und zwar mit den Endteilen der Palpen), sie sind aber wenig zum Festhalten geeignet. Auch die 3. Maxillipede scheinen synchron mit den 1. und 2. Maxillipeden und Cheliceren nach aussen zu bewegen, indem sie das Fleisch festhalten; und zwar geschieht das mit den grossen (vielleicht auch mit den kleinen) Laciniae, während die Endopodite selbst den Mandibeln angedrückt bleiben. Es wird also von den Cheliceren und sämtlichen Maxillipeden gezogen, von den Mandibeln Widerstand geleistet.

Ausführlichere Beobachtungen über die Wirkung der Mundgliedmassen findet man, für *Carcinus moenas*, bei BORRADAILE. Nur sagte ich oben schon dass die Laciniae der 1. Maxillipede, genau wie die Ischiopodite der 3. Maxillipede, die Nahrung beim Auswärtsziehen festhalten; ob sie auch die Funktionen haben, die BORRADAILE vermutet, bleibe dahingestellt. Hauptsache für uns ist, dass wir über die genaue Funktion der Mundgliedmassen bei den Krabben noch herzlich wenig wissen.

Interessant ist ein Vergleich der Nahrungsaufnahme bei diesen Krabben mit der bei den Einsiedlerkrebsen, vgl. ORTON, 1927.

Welche Rolle den Mundgliedmassen von *Uca* bei der Futteraufnahme zukommt, konnte ich durch direkte Beobachtungen also nicht erfahren. Einiges über ihre Funktion kann man vielleicht schliessen aus ihrem Bau, den ich weiter unten bespreche. Dergleichen Schlüsse sind aber meistens ein schlechtes Surrogat für direkte Wahrnehmungen. — Das einzige was man an den Mundteilen einer fressenden *Uca* sieht, ist dass sie schnell hin und herbewegen und wenn man sie gleich nach dem Fressen betrachtet, so findet man zahlreiche feinen „Schlammpartikeln“ zwischen ihnen. Sie besorgen die Scheidung zwischen „brauchbarem“ und „nicht brauchbarem“ Material, die einen so auffallenden Teil des Fressens bildet. Während nämlich die kleine Chelicere fortwährend Futter darreicht, sieht man, wie ein Teil des Schlammes von den Mundgliedmassen sozusagen wieder ausgeschieden wird, indem es sich in einigermaßen flüssiger Form vor der Basis der 3. Maxillipede sammelt. Dadurch dass während des Fressens die Epipodite der 3. Maxillipede in der Milne-Edwardschen Öffnung vor dem Coxalglied der Scherenfüsse hin und herschaukeln (siehe unter Atmung), werden Schlammteil-

<sup>1)</sup> PLATEAU (cf. BIEDERMANN, p. 664) hat angegeben, dass *Carcinus moenas* das Fleisch nicht zerkleinert, sondern in der Form eines langen Fadens aufnimmt, und dass also die Mundteile dazu dienen, diesen Faden zu bilden. Gleiches wird für *Astacus* angegeben. Ob ein Faden gebildet oder das Futter zerkleinert wird, hängt aber mit der Art des Futters zusammen. Kleine Fleischstücke, die schwierig zu zerreißen sind, werden sozusagen von den Mandibeln geknetet und als ganzes aufgenommen, weniger zähes Futter aber nicht. Grosse Fleischstücke werden zerrissen und ihre Teile als Faden aufgenommen.



chen, die auf sie geraten, ebenso medianwärts befördert. MONOD beschrieb diesen Prozess der Futteraufnahme als folgt: „Là il saisit avec ses pinces spatulées des „bouchées“ de sable humide qu'il introduit dans le cadre buccal *par en haut*, entre les segments supérieurs des maxillipèdes externes légèrement écartés. Par cette fente on aperçoit les appendices sous-jacents dans un état de vibration constant, noyés dans un bouillonnement de salive. Entraînée par son poids, émulsionnée pour ainsi dire par son passage dans les peignes des maxillipèdes, la „bouchée“ de sable liquéfiée et lavée de ses particules alimentaires coule vers le bas et vient entre la base des maxillipèdes externes former une grosse goutte qui se solidifie au contact de l'air. Cette goutte, devenue boulette, est saisie par une des spatules et déposée devant l'animal“. Letztere Bewegung ist sehr typisch, besonders da jedesmal nach einer ziemlich konstanten Zahl von „Bissen“ der Schlammklumpen genügend gross ist, fortgenommen zu werden. *Signatus* tut das meistens nach ungefähr 6 bis 16 „Bissen“. Die Klümpchen verweigerten Schlammes werden mit der Schere fortgenommen und vor das Tier deponiert; nicht hinter dasselbe, wie SYMONS für *Uca* angibt, und wie das bei der kleinen *Dotilla* geschieht. Da sie ziemlich feucht sind, sind sie klein und von verschiedener Form. Sie bedecken den Boden ganz regellos. Wo *Uca* (zum Beispiel die Art *consobrinus*) nun aber auf einem harten sandig-schlammigen Boden vorkommt, da werden die Klümpchen grösser, rund und dabei werden sie ausserdem an vielen Stellen in ganz auffallenden Längsreihen deponiert. Diese Längsreihen kleiner Schlamm-sandkügelchen können von der Höhle ausstrahlen und in dieser Weise einen viereckigen Stern bilden, sie können auch konzentrisch um die Höhle herum Linien bilden, oder es können einige lange willkürliche Linien von ihnen gebildet werden. Bisweilen aber liegen sie auch hier regellos. Offenbar macht *U. signatus*, wenn diese Art bisweilen an dergleichen Stellen vorkommt, die gleichen „Figuren“ aus kleinen Kügelchen. — Die Ursache dieser Erscheinung wird deutlich wenn man die Tiere bei der Futtersuche beobachtet. Auf hartem Schlamm-sand ist es für die Tiere schwierig zu fressen wo sie wollen. Es ist einigermassen schwer die Oberflächenschicht zu öffnen, und wenn sie also an einer bestimmten Stelle fortgegessen ist, da setzt die Krabbe die Arbeit in gleicher Richtung fort, weil sie jetzt leicht die Cheliceren von der Seite her unter die Oberflächenschicht bringt. Es entstehen in dieser Weise Linien. Arbeitet sie nun von der Höhle zur Peripherie, und kehrt sie, an einem bestimmten Punkt angelangt, jedesmal zur Höhle zurück, so entstehen viele Linien, die von der Höhle ausstrahlen: die merkwürdige Strahlenfigur. Entsprechend werden auch die konzentrischen und willkürlichen Linien gebildet. Stärker ausgesprochen finden wir diese Fressweise, wobei Strahlenfiguren gebildet werden, bei einigen Krabben, die für diesen schlammigen Sandstrand typisch sind: *Dotilla* und *Scopimera*. Schon ORTMANN (BRONN, p. 1221) beschrieb für *Dotilla fenestrata* eingehend, in welcher Weise die Strahlenfiguren entstehen. Nach SYMONS (p. 309) entstehen die Sandkügelchen bei *Dotilla* in etwas anderer Weise als bei *Uca*: „the sand passes into the mouth from below and emerges above to form a sort of ball or pellet, which is held in position by the maxillary palps which extend outwards



from the mouth." Man fragt sich unwillkürlich ob diese Beobachtung richtig ist. Die Kügelchen werden auch hier mit den Cheliceren fortgenommen und wie ich bei Batavia für *Dotilla* feststellte, unter der Krabbe hindurch nach hinten geworfen. SYMONS beobachtete *D. mycteroides*, ich *D. wichmanni*. SYMONS bildet zwei Höhlen und die Sandkügelchen von *Scopimera* species ab, und gibt einige Bemerkungen über letztere Art.

"Their method of feeding is exactly the same as that of the *Dotilla* species, but the pellets of sand are often as large as the body of the crab before they are removed from the mouth and placed on the heap. Their burrow "paths" and piles of "eaten" sand are much more orderly than those of the *Dotilla*. Just after the tide has fallen and the sand become fairly dry, this neatness is most marked. They work a path, which is about three-quarters of an inch wide, and only scrape it on the surface to form a shallow groove, all the pellets being placed on one side of the path, that is, in eating they always appear to face in one direction. Occasionally an aberrant one is seen, feeding in an irregular manner so far as the pathways are concerned, but the actual method of handling the sand is always the same, and there is no possibility of mistaking the work of one of these crabs for the work of an *Oecypode* in clearing out its burrow".

Es sei aber hinzugefügt, dass die Variabilität in der „Figurenbildung“ der von ihm beschriebenen Arten vermutlich viel grösser sein wird als er sagt; auch seine übrigen Beobachtungen hätten exakter sein können. — Weiter macht auch GRAVELEY einige Bemerkungen über *Scopimera*, und zwar über *S. proxima* KEMP und *S. pilula* KEMP. *S. proxima* macht nach ihm die oben besprochenen Längsreihen, *pilula* aber nicht, *S. proxima* lebt höher, dichter bei der Hochwassergrenze als *pilula*. Das stimmt mit meinen Befunden, dass auf härterem Schlamm Längsreihen gebildet werden, auf feuchterem nicht.

In gleicher Weise wie bei *Uca*, wo diese Art auf feuchtem Schlamm vorkommt, werden die Klümpchen von *Ilyoplax*, *Metaplax* und *Paracleistostoma* ganz willkürlich deponiert. Nicht stets aber brauchen alle diese Arten überhaupt Schlammklümpchen zu bilden. Bisweilen nämlich fressen die Tiere unter der Wasseroberfläche. Von *Uca*, und zwar von *signatus*, und weiter von *annulipes* und *urvillei* aus Ceram, sah ich das nur in der Gefangenschaft, von *Metaplax* auch draussen. Tun sie das, so bildet sich kein Schlammklumpen, sondern das ausströmende Atemwasser entfernt den verweigerten Schlamm. Man beobachtet also einen feinen Doppelstrom, alsob man das Atemwasser mittels Chinesischer Tusche sichtbar gemacht hätte.

In welcher Weise die Mundgliedmassen die Scheidung des Schlammes in brauchbares und nichtbrauchbares Material vornehmen, weiss ich also nicht <sup>1)</sup>. Dass aber die Mundgliedmassen von *Uca* der Schlammarbeit angepasst sind, leuchtet einem sofort ein, wenn man sie mit denen einer Grobnahrung fressenden Krabbe vergleicht. — Gute Abbildungen von Krabbenmundteilen gab PEARSON für *Cancer pagurus* und BORRADAILE für *Carcinus moenas* <sup>2)</sup>. Vergleicht man die

<sup>1)</sup> Ich schliesse die Möglichkeit aus, dass die Scheidung des Schlammes in brauchbares und unbrauchbares Material im Magen, statt von den Mundteilen besorgt wird.

<sup>2)</sup> Ich könnte auch die Abbildungen von Krabbengliedmassen aus BRONN (Taf. 81) benutzen, fürchte aber, dass sie etwas zu schematisch sind.



Mundteile von *Uca* (Fig. 7-13) mit denen dieser beiden Arten, so ist besonders die ganz starke Beborstung auffallend. Es ist logisch, anzunehmen, dass dies mit der Lebensweise der von uns studierten Tiere im feuchten Schlamm zusammenhängt.

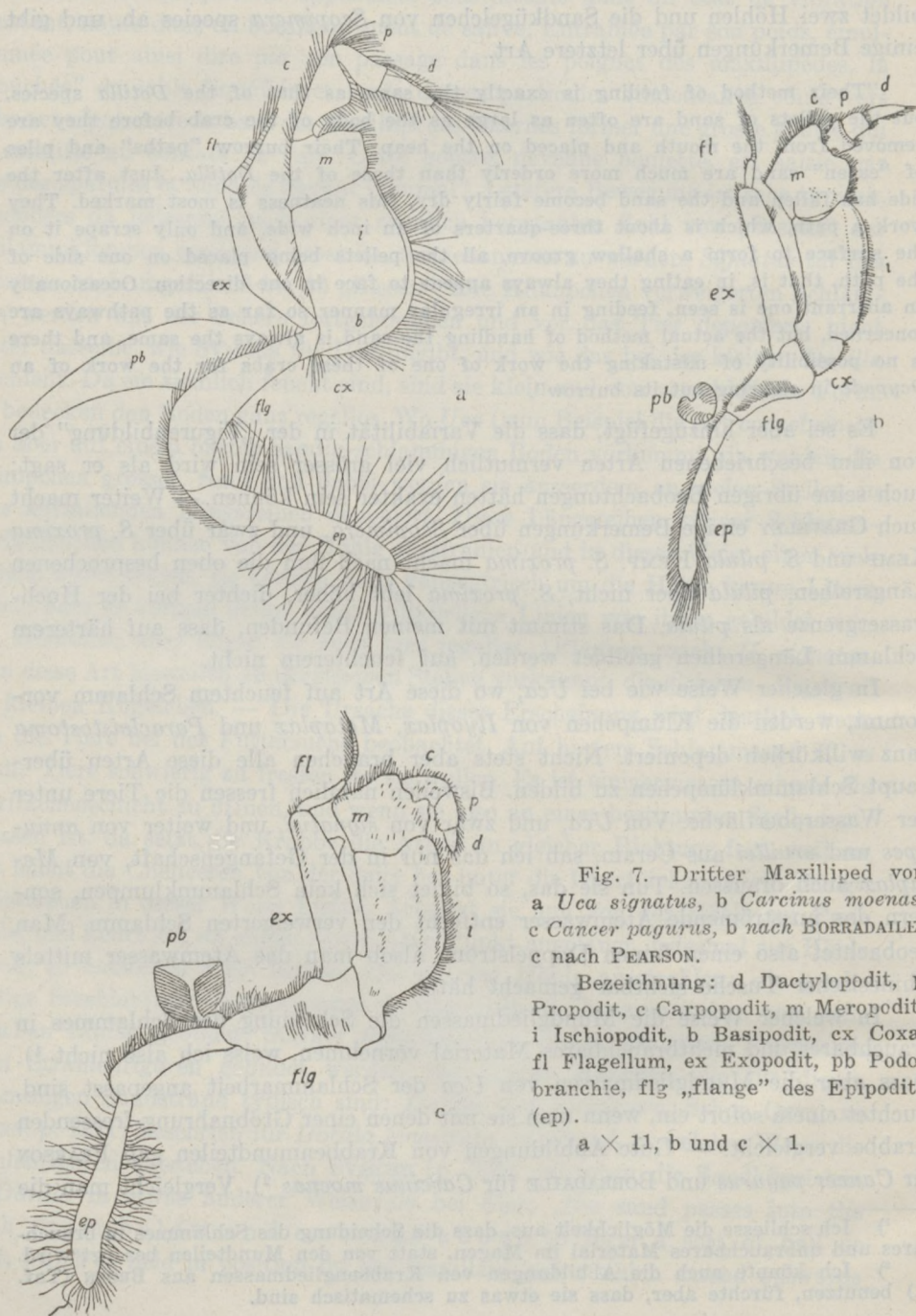


Fig. 7. Dritter Maxilliped von  
a *Uca signatus*, b *Carcinus moenas*,  
c *Cancer pagurus*, b nach BORRADAILE,  
c nach PEARSON.

Bezeichnung: d Dactylopodit, p Propodit, c Carpopodit, m Meropodit, i Ischiopodit, b Basipodit, ex Coxa, fl Flagellum, ex Exopodit, pb Podobranchie, flg „flange“ des Epipodits (ep).

a  $\times 11$ , b und c  $\times 1$ .



Ausser diesen Unterschieden in der Beborstung gibt es aber, wie zu erwarten, weitere Unterschiede, die wir kurz besprechen wollen. Vergleicht man die 3. Maxillipede der drei Arten (Fig. 7), so ist die Länge der Palpen (Carpo-, Pro- und Dactylopodit) hervorzuheben, die bei *Uca* zusammen ebensolang sind wie Mero-, Ischio- und Basipodit, während sie bei den beiden anderen Arten ungefähr halb so lang sind als diese. Diese Länge ermöglicht die Reinigung der langgestielten Augen, die noch erleichtert wird durch die ganz langen Borsten, die sich am Ende des Dactylopodits befinden. Bei näherer Vergleichung treten an den 3. Maxillipeden weitere Unterschiede hervor; diese entnehme man aber den Figuren. — Eine Vergleichung der 2. Maxillipede (Fig. 8) ergibt,

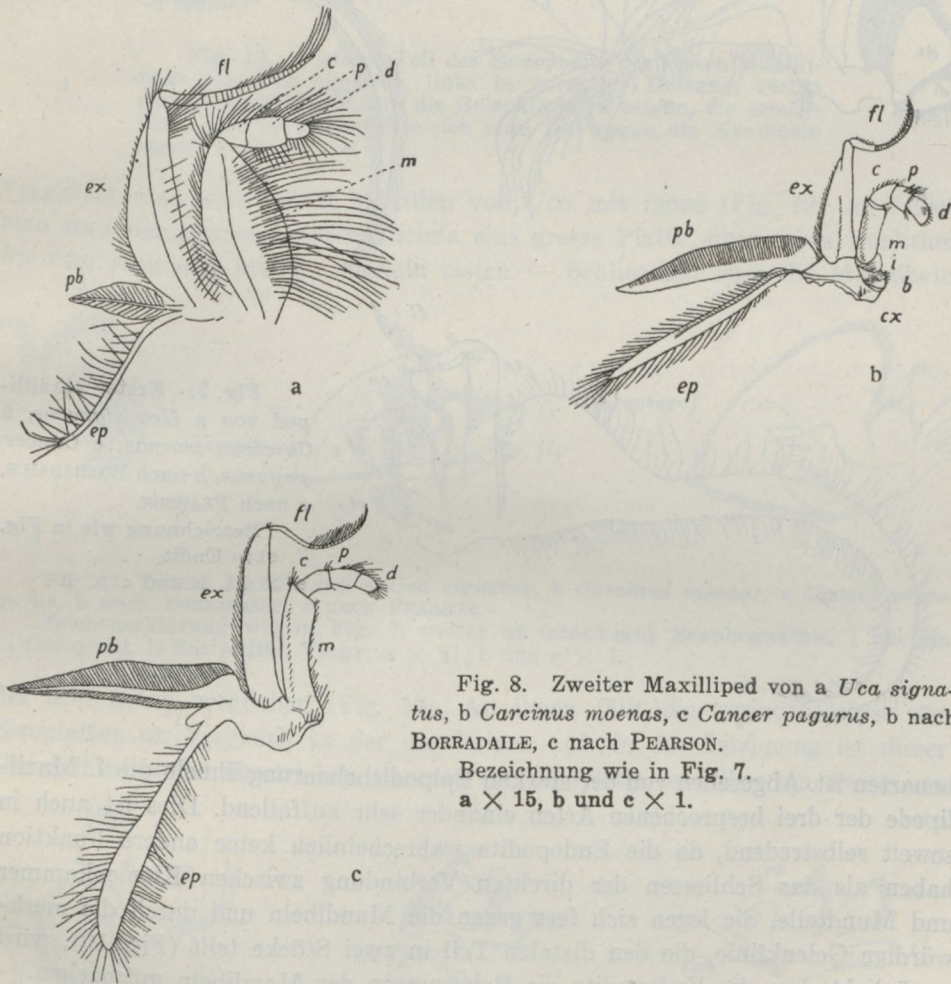


Fig. 8. Zweiter Maxilliped von a *Uca signatus*, b *Carcinus moenas*, c *Cancer pagurus*, b nach BORRADAILE, c nach PEARSON.

Bezeichnung wie in Fig. 7.

a  $\times 15$ , b und c  $\times 1$ .

ausser der ganz auffallend starken Behaarung und der geringen Grösse der Kieme am Epipoditbasis, keine auffallenden Unterschiede. Die starke Behaarung mag darauf hinweisen, dass den 2. Maxillipeden eine wichtige Rolle bei



der Futteraufnahme (resp. der Scheidung in brauchbares und unbrauchbares Futter) zukommt.— In dieser Annahme wird man noch bestärkt wenn man sieht wie gering der Unterschied in den 1. Maxillipeden (Fig. 9) der drei Krab-

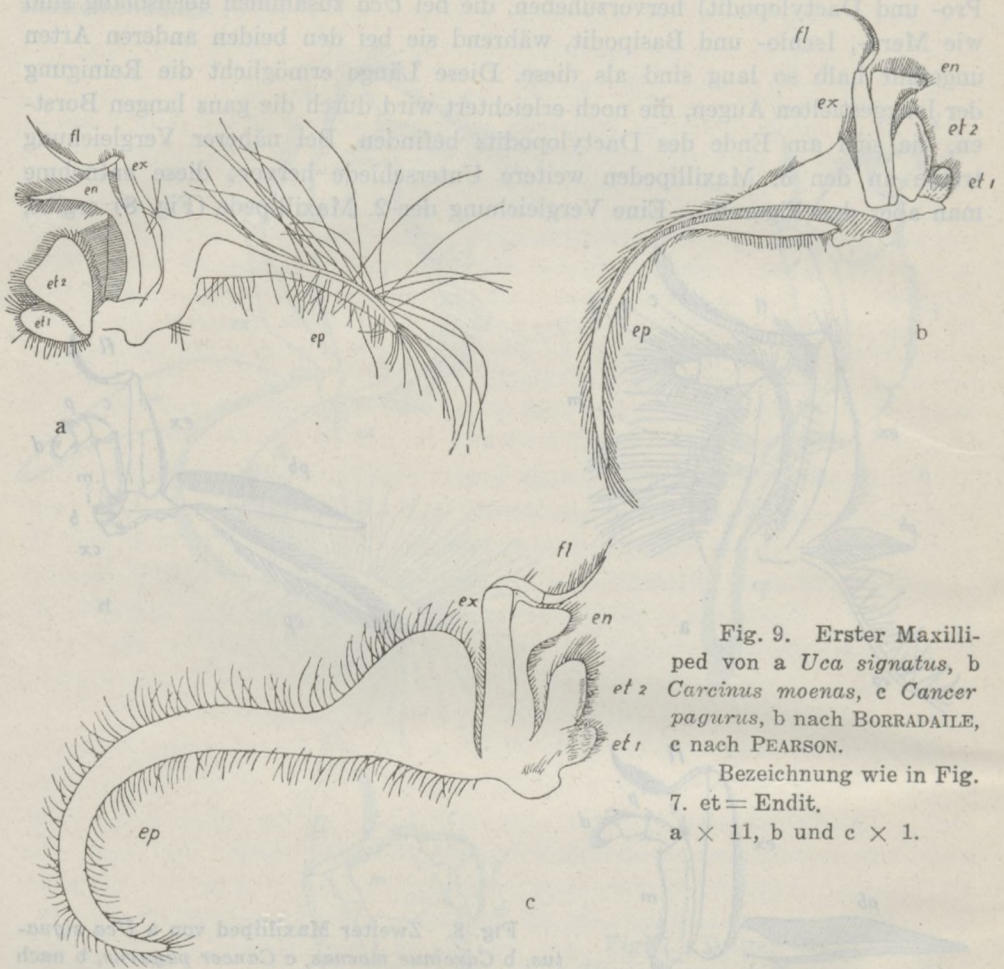


Fig. 9. Erster Maxilliped von a *Uca signatus*, b *Carcinus moenas*, c *Cancer pagurus*, b nach BORRADAILE, c nach PEARSON.

Bezeichnung wie in Fig. 7. et = Endit.

a  $\times 11$ , b und c  $\times 1$ .

benarten ist. Abgesehen von der starken Epipoditbehaarung ähneln die 1. Maxillipede der drei besprochenen Arten einander sehr auffallend. Dies ist auch in soweit selbstredend, da die Endopodite wahrscheinlich keine andere Funktion haben als das Schliessen der direkten Verbindung zwischen Kiemenkammer und Mundteile. Sie legen sich fest gegen die Mandibeln und durch die merkwürdige Gelenklinie, die den distalen Teil in zwei Stücke teilt (Fig. 10), wird ermöglicht dass die Endopodite die Bewegungen der Mandibeln mitmachen.— Vergleicht man nun die übrigen Mundteile, so unterscheiden die 2. Maxillen von *Uca signatus* sich stark von denen der beiden anderen Arten. Die geringe Grösse dieser Mundteile bei *Uca* erschwert ihr Studium, die mangelhafte Abbildung (Fig. 11) zeigt aber deutlich die relativ gewaltige Grösse der Laciniae



im Verhältnis zum Scaphognathit und, wie bei den 2. Maxillipeden, ihre ganz starke Beborstung. — Obgleich die 1. Maxillen von *Carcinus* und *Cancer* unter sich etwas verschieden sind, ist ihr Bau bei diesen Arten im Prinzip der gleiche.

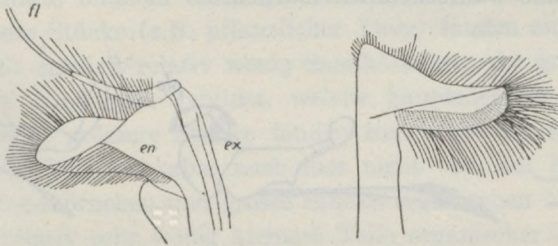


Fig. 10. Distaler Teil des Endopodits des ersten Maxillipeds von *Uca signatus*, links in normaler Haltung, rechts extrem ausgeklappt, um die Gelenklinie zu zeigen, die ermöglicht, dass die Endopodite sich stets fest gegen die Mandibeln legen. Vergr.  $\times 18$ .

Vergleicht man aber die 1. Maxillen von *Uca* mit ihnen (Fig. 12), so findet man statt der kleinen inneren Lacinia eine grosse Platte, über deren Funktion wir zum sovielen Mal im dunkeln tasten. — Schliesslich seien die Mandibeln

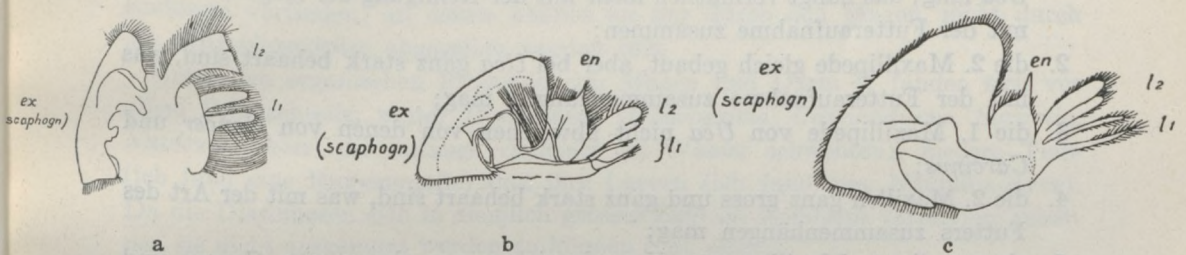


Fig. 11. Zweite Maxille von a *Uca signatus*, b *Carcinus moenas*, c *Cancer pagurus*, b nach BORRADAILE, c nach PEARSON.

Zeichenerklärung wie in Fig. 7, weiter ex (scaphogn) Scaphognathit, l Lacinia (l1 Coxopodit, l2 Basipodit). Vergr. a  $\times 11$ , b und c  $\times 1$ .

der drei Arten verglichen (Fig. 13). An ihnen fällt die geringe Grösse der Kauplatten im Vergleich zu der der Palpen auf (in der Zeichnung ist dieser Unterschied etwas übertrieben, da man die Kauplatte von *Uca* ein wenig von

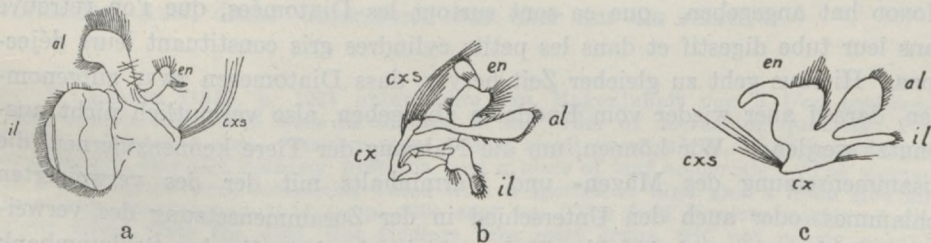


Fig. 12. Erste Maxille von a *Uca signatus*, b *Carcinus moenas*, c *Cancer pagurus*, b nach BORRADAILE, c nach PEARSON, cx Coxa, cxS setae der Coxa, al äussere Lacinia, il innere Lacinia. Vergr. a  $\times 11$ , b und c  $\times 1$ .



der Seite, nicht ganz von vorn sieht). Diese geringe Grösse mag mit der geringen Grösse der aufgenommenen Nahrungspartikelchen zusammenhängen, aber erst eine Vergleichung mehrerer Krabbenarten oder direkte Beobachtung könnte eine solche Annahme wahrscheinlich machen.

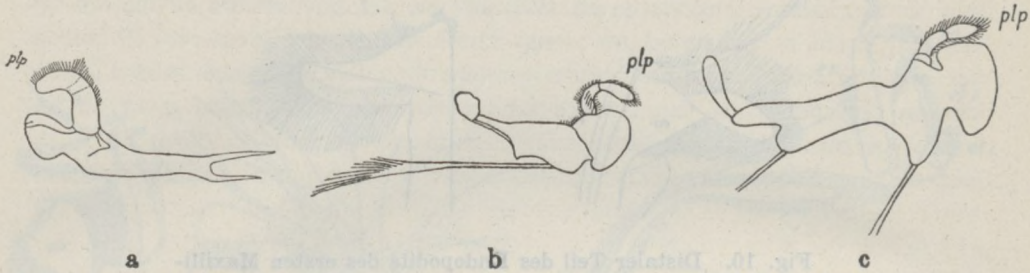


Fig. 13. Mandibel von a *Uca signatus*, b *Carcinus moenas*, c *Cancer pagurus*, b nach BORRADAILE, c nach PEARSON. plp Palpe. Vergr. a  $\times 11$ , b und c  $\times 1$ .

Zusammenfassend ergibt sich bei einer Vergleichung der Mundteile von *Uca* mit denen von *Cancer* und *Carcinus*, dass:

1. die 3. Maxillipede im Prinzip gleich gebaut sind; nur die Palpen sind bei *Uca* lang; das hängt vermutlich mehr mit der Reinigung der Augen, usw. als mit der Futteraufnahme zusammen;
2. die 2. Maxillipede gleich gebaut, aber bei *Uca* ganz stark behaart sind, was mit der Futteraufnahme zusammenhängen mag;
3. die 1. Maxillipede von *Uca* nicht abweichen von denen von *Cancer* und *Carcinus*;
4. die 2. Maxillen ganz gross und ganz stark behaart sind, was mit der Art des Futters zusammenhängen mag;
5. ebenso die 1. Maxillen von *Uca* abweichen von denen von *Cancer* und *Carcinus*;
6. die Mandibeln von *Uca*, verglichen mit denen von *Cancer* und *Carcinus*, eine ganz kleine Kauplatte haben, was mit der Art des Futters zusammenhängen mag.

Man fragt sich, was nun bei dieser Scheidung des Schlammes in zwei Komponente als brauchbar aufgenommen und was nach aussen fortgeschafft wird. MONOD hat angegeben, „que ce sont surtout les Diatomées, que l'on retrouve dans leur tube digestif et dans les petits cylindres gris constituant leurs déjections.“ Hieraus geht zu gleicher Zeit hervor, dass Diatomeeen zwar aufgenommen, darauf aber wieder vom Enddarm abgegeben, also vermutlich nicht ausgenutzt werden. — Wir können, um die Nahrung der Tiere kennenzulernen, die Zusammensetzung des Magen- und Darminhalts mit der des verweigten Schlammes, oder auch den Unterschied in der Zusammensetzung des verweigten Schlammes und der Oberflächenschicht der betreffenden Schlammbank vergleichen. Den Unterschied in der Zusammensetzung des gegessenen und verweigten Schlammes untersuchte ich für *Uca signatus*. Und zwar untersuchte



ich einerseits den Magen- und Darminhalt, andererseits die Zusammensetzung der Klümpchen verweigten Schlammes. Ich fand dabei folgendes. Das verweigte Material bestand zu einem grossen Prozentsatz aus Sandkörnern; organische Produkte bildeten einen gewissen Anteil, aber die Teilchen waren klein und grössere Stücke (z.B. pflanzlicher Teile) fanden sich ziemlich wenig. Der Mageninhalt enthielt relativ wenig Sandkörnern, der grössere Teil wurde von organischen Produkten gebildet, welche hauptsächlich aus sehr kleinen Stücken bestanden; grössere Stücke fanden sich vielleicht etwas mehr als in dem verweigten Material, aber auch hier nicht viel. Im Enddarm fand ich hauptsächlich Sandkörnern und grosse Stücke organischen Materiales (in casu Pflanzenteile), relativ sehr wenig kleinere Teile organischer Produkte. Hieraus geht hervor: 1. dass von den Mundgliedmassen mehr eine Sichtung nach der Qualität als nach der Grösse des Materiales stattfindet, da in der Hauptsache sowohl grössere wie kleinere Stücke organischen Materiales aufgenommen, grössere und kleinere Sandkörnern verweigert werden; 2° dass die Tiere den Schlamm nur unvollkommen auszunutzen im Stande sind, da auch das verweigte Material einen gewissen Teil organischer Reste enthält; 3° dass von dem aufgenommenen Material die grösseren Stücke organischen Stoffes (in casu gröbere Pflanzenteile) nicht ausgenutzt werden, da sie sich unzerteilt im Enddarm vorfinden; an diesen können sie nur durch den Magen, nicht durch die Mitteldarmdrüse abgegeben worden sein.

Unter den organischen Produkten im Magen und Darm <sup>1)</sup> fanden sich vor allem Pflanzenteile, weiter Diatomeen (*Pleurosigma*, *Coscinodiscus*, *Surirella*, *Navicula*), Eier (die anfangs vielleicht im Wasser schwebten), niedere Tiere (ich fand eine Rippenqualle) und ihre Larven (ich fand eine Nauplius-larve). Da die Diatomeen sich in ziemlich grosser Zahl im Enddarm vorfanden, scheinen sie nicht ausgenutzt werden zu können (vgl. oben).

Ich untersuchte weiter den Unterschied in der Zusammensetzung des verweigten Schlammes und der Oberflächenschicht der betreffenden Schlammbank, und zwar tat ich dies für *Uca consobrinus*. Der verweigte Sandschlamm von *Uca consobrinus* (die Art bewohnt an der Stelle, wo ich sammelte, stark sandigen Schlamm) enthielt weniger organische Bestandteile als der noch nicht berührte Oberflächenschlamm und zwar schienen mir besonders die feinen organischen Bestandteile verschwunden, während die grösseren sich im Material vorfanden. Auch dieser Unterschied war aber nur ein relativer.

<sup>1)</sup> PEARSE (1912, p. 122) untersuchte den Mageninhalt von 6 *Uca rathbunae*. "The objects discovered were as follows, in the order of decreasing quantity: Plant tissue, a branched alga, vascular plant tissue, small green algae, small brown spores or cysts (?), fine silt, diatoms, protozoa, and a piece of leaf epidermis". "The stomachs of 2 individuals were completely filled with a species of alga and a little fine silt". In seinem Beitrag von 1914 (a. p. 420) sagt er: "The food consists mostly of small algae sifted from the mud. But fiddlers, like most crabs, will eat nearly anything that is cast upon the beach—dead fish, dead crabs, plants, etc." Letzteres ist für die von mir studierten Arten bestimmt unrichtig, denn sie verweigern jedes gröbere Futter, seien dies Fische oder Graswurzeln, wie sie von *Sesarma* gern aufgenommen werden.



Hieraus lässt sich also schliessen dass die Tiere den Schlamm nur unvollständig auszunutzen imstande sind <sup>1)</sup>. Es wird ein Teil der organischen Produkte aufgenommen und einem Teil des Sandes der Zutritt verweigert, aber eine vollständige Scheidung gibt es nicht. Man würde also den Tieren das verweigte Futter zum zweiten und dritten Mal füttern können, nur würden sie jedesmal weniger kriegen. Gleiches gilt vielleicht für andere Schlammfresser, z.B. einige Holothurien. Höchstwahrscheinlich spielt dieses zweimalige oder sogar ein wiederholtes Fressen eines bestimmten Schlammes auch draussen eine gewisse Rolle. In Zeiten sehr niedrigen Hochwassers gibt es Schlammbanken die, obgleich sie von zahlreichen Krabben bewohnt sind, nicht vom Wasser erreicht werden. Sie sind bald bedeckt mit vielen Hunderten Klümpchen verweigten Futters, die jeden Tag an Anzahl zunehmen, bis sie zuletzt fast den ganzen Boden bedecken. Da sie aber der Sonne und dem Regen ausgesetzt sind, werden sie zerfallen und aufs neue zum Futter dienen, wie es auch bei gefangenen Tieren geschieht, wenn man sie nicht gut versorgt. — Übrigens trocknen diese Banken, wenn das Wasser sie einige Zeit nicht bedeckt, so stark ein (man sehe Tafel X), dass die Krabben alsbald weniger heraus kommen, wie auch in der Gefangenschaft ein Austrocknen des Schlammes die Tiere drinnen hält. PEARSE (1914a, p. 416) bemerkt denn auch: "during low tides those (burrows) on higher ground may be left open day after day, though the flats dry out to such an extent that crabs can not feed easily and remain at the bottoms of their burrows". — Überhaupt gibt die Versorgung der Tiere uns ein lehrreiches Bild von ihren Bedürfnissen und optimalen Lebensbedingungen. Man kann die Tiere ganz lange auf ziemlich kleinem Raum halten, wenn man nur oft das Wasser bis über den Schlamm steigen, sodann kürzere oder längere Zeit (einige Stunden bis einen Tag) stehen lässt, und es darauf wieder fortnimmt. Man muss es dann ausserdem einige Zeit vor dem Absaugen gut in Bewegung bringen, damit eine neue Oberflächenschicht gebildet wird, die den Tieren neues Futter verschafft.

Wir sind dem Futter jetzt bis in den Darm gefolgt. Wir wissen dass die Tiere, obgleich sie zu der so interessanten biologischen Gruppe der Schlammfresser gehören, sich dennoch prinzipiell nicht von ihren zahlreichen grösseren und kleineren Verwandten, die fast alle typische Omnivore sind, unterscheiden lassen. Es würde also von grossem Interesse sein zu wissen ob sie auch in ihrer Physiologie mit diesen Verwandten übereinstimmen. Wir wissen dass der typische Omnivor *Astacus* (*fluvialis* sowie *macrodactylus*), genau wie der omnivore Mensch, einen Magensaft besitzt, der alles leisten kann, was die Saftgemische der Wirbeltiere zu leisten imstande sind. Besonders JORDAN und seine Schüler haben gezeigt, wie, obgleich unter teilweise ganz andern Umständen (unter anderem  $P_H$ ) als bei den Wirbeltieren, auch bei *Astacus* die aufgenommenen Kohlehy-

<sup>1)</sup> L. HARRISON MATTHEWS gab kürzlich einige Beobachtungen über die Biologie von *Uca leptodactyla* RATHBUN. Leider ist der Beitrag oberflächlich; die Angaben über die Scheidung des Sandes durch die Mundteile sind offenbar hypothetisch, die Figuren sind grob. Der Autor ist aber der erste, der die langen Borsten der 1. und 2. Maxillipede beschreibt; weiter weist er darauf hin, dass die Endopodithaare der 2. Maxillipede teilweise löffelförmig enden.



drate, Fette und Eiweisse aufnahmefähig gemacht werden. Ihre und andere Untersuchungen haben hier Besonderheiten zu Tage gefördert, die es erst jetzt ermöglichen, die Verdauung bei den Wirbeltieren in richtiger Beleuchtung zu sehen. — Ich habe also den Magensaft von *Uca signatus* in dieser Richtung untersucht, nur mit dem Zweck festzustellen, in wie weit er mit dem von *Astacus* übereinstimmt <sup>1)</sup>. Betreffs der Methode sei nur bemerkt, dass ich zur Absaugung des Magensaftes (vgl. JORDAN, 1927) eine Glasröhre mit äusserst feiner Spitze benutzte und ungefähr 35 Tiere brauchte für jeden c.c. Saft. Im ganzen benutzte ich ein paar hundert Tiere, deren Chelipede und 3. Maxillipede ich vor dem Abpipettieren fortnahm, da sonst die feine Pipette durch sie gebrochen wurde. Ich nahm ausschliesslich Tiere, die einen bis drei Tage gehungert hatten. Ausser in den Versuchen mit dem Bindegewebe wurde der Magensaft mit NaCl 1.2 % verdünnt, was keine Trübung zur Folge hatte (bei Verdünnung mit destilliertem Wasser und NaCl 4 % schien eine leichte Trübung einzutreten). Besser wäre gewesen wenn ich erst die Gefrierpunktserniedrigung des Blutes festgestellt hätte.

Der Magensaft dieser Tiere ist braun bis dunkelbraun und reagiert schwach sauer; die elektrometrische Bestimmung ergab ein  $P_H$  von 5.1 (*Thalassina anomala* nach elektrometrischer Bestimmung ebenso 5.1 im Hungerzustand, *Astacus* nach SHINODA 5.— bis 5.6). Die verdauende Wirkung des Saftes wurde untersucht an Bindegewebe, Fibrin, Milch, Amylum und Sacharose.

1. **Wirkung auf Fibrin.** Benutzt wurde durch Carmin gefärbtes Fibrin.
 

Magensaft (1 : 10) (½ c.c.) .....	Fibrin langsam verzehrt.
„ (wie oben) + Na <sub>2</sub> CO <sub>3</sub> (2%) .....	schnelle Verzehung.
„ ( „ „ ) + HCl (½ c.c. 0.2%) .....	keine Verzehung.
„ (gekocht) .....	„ „

Es wurde soviel Na<sub>2</sub>CO<sub>3</sub> zugefügt, dass Lackmus schwach blau gefärbt wurde, während ½ c.c. HCl 0.2% es schwach rot färbte.  
Aus diesen Beobachtungen lässt sich schliessen, dass der Saft eine Protease enthält, die schneller in alkalischem als in schwach saurem Milieu verzehrt.
2. **Wirkung auf Catgut.** Benutzt wurde Catgut, wie es bei Operationen Verwendung findet.
 

a. Magensaft (unverdünnt) .....	langsame Verzehung.
b. „ ( „ „ ) .....	„ „
3. **Wirkung auf Fett.** Benutzt wurde Kuhmilch, mit Phenolphthaleine als Indikator. Sogar eine stark rosa Färbung verschwand bis zweimal nach Beifügung einer kleinen Menge Magensaft (1: 10). In der Kontrollprobe, die einen Augenblick gekocht wurde, blieb diese Färbung nicht ganz aus, sie war aber schwach und verlief nur sehr allmählich (zu kurz gekocht). Es enthält der Saft also eine Lipase.
4. **Wirkung auf Stärkemehl.** Benutzt wurde lösliche Stärke, 1/6, 1/30 und 1/150 %. Stets unmittelbare Zersetzung der Stärke und Schwund der von I-IK herrührende Färbung bei Zusatz des Magensaftes (1: 10).  
Es enthält der Saft also eine Amylase.

<sup>1)</sup> Ich wähle also *Astacus*, obgleich keine Krabbe, da die Ernährungsphysiologie dieser Art so genau bekannt ist. Gern hätte ich auch den Beitrag YONGES über *Nephrops* zur Vergleichung herangezogen, kann ihn aber in Batavia nicht zu Gesicht bekommen.



## 5. Wirkung auf Saccharose.

1 c.c. Magensaft + 2 c.c. Rohrzucker (2/3%)

+ Fehling.....: allmähliche Reduktion der Fehlingschen Lösung.

Magensaft + Fehling.....: keine Änderung.

Rohrzucker + „ .....: „ „

Es enthält der Saft also eine Invertase.

Vergleichen wir nun die erhaltenen Resultate mit denen von *Astacus*, so muss ich erst hinzufügen dass ich mir davon bewusst bin, dass meine groben Beobachtungen eigentlich nicht mit den schönen und ausführlichen Untersuchungen über *Astacus* verglichen werden dürfen. Durch die Untersuchungen besonders von JORDAN, KRÜGER und SHINODA kennen wir die Eiweisspaltung von *Astacus* ganz gut, u.a. durch den Beitrag von WIERSMA und VAN DER VEEN sind wir auch über die Karbohydrasen des Saftes gut unterrichtet. Sogar der grobe Vergleich der genannten Dekapoden zeigt uns aber genügend, dass sie prinzipiell in ihrer Verzehrunphysiologie übereinstimmen, eine an und für sich in bezug auf die ganz verschiedene Nahrungsarten der beiden Tiere interessante Feststellung. Eine ausführlichere Untersuchung, u.a. auf Zytase, Maltase und andere Enzyme, würde zweifellos diese Übereinstimmung noch bestätigen.

## 4. DIE PROBLEME DER KRABBenATMUNG.

Wir haben im ersten Teil gesehen, dass das Problem der Atmung bei den Mangrovetieren ein recht interessantes sein muss, da es unter ihnen Land- und Wasserformen in der gleichen Tiergruppe gibt. Das ganze Kapitel der Brachyurenatmung, einschliesslich das der Atmungsbewegungen, ist noch sehr unvollständig bekannt, desto verwirrter sind die Angaben, wo es die schlecht untersuchten tropischen Formen gilt. Ich ziehe deshalb vor, hier *Uca* am Ende, statt am Anfang zu besprechen und behandle erst die Atmung bei den Krabben im allgemeinen.

Es macht einen gewissen Unterschied ob wir eine richtige Wasserkrabbe oder eine amphibisch lebende Krabbenart studieren. Ich fange mit ersterer an und wähle dazu eine Art, welche mir leicht zur Verfügung steht und den Vorteil hat die Untersuchung zu erleichtern durch ihre Grösse: *Scylla serrata*. — Mittels Carmin lässt sich leicht feststellen, dass *Scylla*, wenn unter der Wasseroberfläche gehalten, vor dem Coxalglied der Scherenfüsse (die Milne-Edwardsche Öffnung BORRADAILES) ein-, durch die bekannte Exhalationsöffnung ausatmet.

"The flange and the base of the epipodite stand in that gap, between the anterior face of the coxa of the cheliped and the branchiostegite, which is the anterior inhalent opening of the gill-chamber; and their twisted shape bears such a relation to the opening that when the maxillipeds are in the normal position they lie across it and almost but not quite close it, but when the maxillipeds are divaricated, the epipodites lie in the midst of the opening, with their flat sides parallel to the stream, to which they offer little opposition. The part of the opening which is covered when the maxillipeds are approximated is the anterior. The extent to which the hinder part remains open varies with the position of the cheliped" (BORRADAILE).



Diese Beschreibung gilt für *Carcinus* und einige andere Krabben, z.B. *Cancer*, nach ORTMANN (p. 1033) auch für *Portunus*, *Hyas*, *Pisa*, *Herbstia*, u.a. Bei den Schwimmkrabben *Scylla serrata*, *Neptunus pelagicus*, *Thalamita crenata* ist die Inhalationsöffnung so gross, dass sie stets, auch bei „geschlossenen“ 3. Maxillipeden, offen bleibt. Nach AUDOUIN und MILNE-EDWARDS (1828) (BABAK, p. 349) ist bei *Maia squinado* die Eintrittsöffnung bei einander genäherten Kieferfüssen ganz verschlossen. Bei *Sesarma* ist der Basalteil des Epipodits stark entwickelt und ganz stark behaart. Der Epipodit bewegt hier ohne Unterbrechung in der Milne-Edwardschen Öffnung, in die er gerade hinein passt, hin und her, ohne aber die Öffnung zu vergrössern, da der Basalteil des Epipodits sich weit nach vorn, teils ausserhalb der Milne-Edwardschen Öffnung, befindet. Diese Bewegung ist unabhängig vom Endopodit des 3. Maxillipeds, der dabei meistens „geschlossen“ ist; auch ausserhalb des Wassers wirkt der Epipodit. Gleiches oder ähnliches findet man bei *Metaplex elegans*, *Uca* (z.B. *signatus*), *Grapsus*, und wahrscheinlich bei *Ilyoplax delsmanni* und *Macrophthalmus definitus*; bei *Uca* (u.a.?) schaufelt der Epipodit (unabhängig vom Endopodit) nur während des Fressens, bewegt dadurch den verweigerten Schlamm medianwärts. Bei der kleinen Süsswasserkrabbe *Sesarma nodulifera* DE MAN, die ich in Tjibodas (1250 m über dem Meer) untersuchte, schliesst der Epipodit die Milne-Edwardsche Öffnung zwar weniger ab, die Haare sind aber länger und der Epipodit schaufelt auch hier ununterbrochen hin und her, genau wie bei den anderen *Sesarma*-arten<sup>1)</sup>. Die Bedeutung dieser auffallenden Bewegung wird klar, sobald man Schlamm- oder Carminpartikelchen in die Nähe der Milne-Edwardschen Öffnung bringt. Sie werden durch diese Bewegung fortgeschafft und zwar medianwärts, so dass sie auf den Basalstücken der 3. Maxillipede zu liegen kommen. Wie sie von da fortgeschafft werden, weiss ich nicht. Bringt man ein wenig Schmutz auf die „Schaufel“, so fängt sie schneller und regelmässiger zu arbeiten an. Deshalb schaufelt *Uca*, wie gesagt, nur oder ganz besonders während der Futteraufnahme. Ob etwas derartiges sich bei anderen Arten mit dichten Haarborsten an der Milne-Edwardschen Öffnung findet (vgl. ORTMANN, p. 1033, p. 1037), lasse ich dahingestellt.

Nimmt man *Scylla* aus dem Wasser heraus und untersucht in wie weit das Branchiostegit eine unvollkommene Abschliessung der Atemkammer bewirkt, so findet man dass nur über der Basis des letzten Thorakalfusses eine schmale Öffnung ist. Von einer Öffnung vor oder über den übrigen Beinbasen lässt sich nichts feststellen. Carmin wurde in meinen Versuchen an den Stellen nicht eingesogen; es gelang mir sogar kein einziges Mal, zu zeigen, dass die Krabbe über dem 5. Thorakalfuss, durch die hintere Inhalationsöffnung PEARSONS, Wasser einsaugt; dennoch kann diese Öffnung nicht umsonst da sein: die Krabbe wird die Wasseraufnahme durch diese regulieren können durch die Haltung der betreffenden Beine, der Schwimmbeine.

Die gleichen Verhältnisse beschrieb PEARSON für *Cancer*. Die Milne-Edwardsche Öffnung nennt PEARSON die vordere, die Öffnung über dem Schwimmfuss die hintere Inhalationsöffnung. PEARSON konnte zeigen, dass auch durch letztere Öffnung Wasser aufgenommen wird, obgleich die Milne-Edwardsche Öffnung den Haupteingang bildet. Die Beobachtungen an diesen Arten bilden also eine Bestätigung der klassischen Wahrnehmungen MILNE-EDWARDS', nach denen im

<sup>1)</sup> Bei dieser kleinen Art verursacht der Zug der Muskeln beim Auswärtsbewegen des Epipodits, dass die Basalteile der 3. Maxillipede jedesmal etwas mit nach auswärts gezogen werden.



allgemeinen bei den Krabben nur eine einzige Öffnung, die vor dem Scherenfuss, zur Aufnahme des Wassers dient.

Anders verhält sich *Carcinus moenas*. Diese Art wurde u.a. von LIM (1918) und besonders ausführlich von BORRADAILE (1922) untersucht. Das Wasser wird hier nicht nur vor dem Coxalglied des Scherenfusses, sondern ausserdem über jedem Thorakalfuss (einschliesslich des Chelipeds) aufgenommen. Es besteht eine schmale Öffnung zwischen je zwei Beinen und das aufgenommene Wasser strömt durch die hypobranchialen Kanäle BORRADAILLES zum Hypobranchialraum. Nach BORRADAILE finden sich auch bei BELL (1853), GIARD und BOHN (1897 und 1907) Angaben darüber, dass Wasser über allen Beinbasen aufgenommen wird; BOHN (1897) soll aber in diesem Zusammenhang gestrichen werden. — Gleiche Verhältnisse finden sich vielleicht bei *Corystes cassivelaunus* (vide GARSTANG, 1896, p. 229).

Abweichend verhalten sich weiter einige andere Arten, die Leucosiiden, Raniden, u.a., vgl. ORTMANN, p. 1032 und 1034, BABAK, p. 349 und STEBBING, p. 140 - 143.

Das einfache Schema der Einatmung, nur durch die Milne-Edwardsche Öffnung, finde ich in gleicher Weise bei allen von mir untersuchten Arten, mit Ausnahme von *Ocypode* und *Uca*. Bei keiner Art, wenn unter Wasser gehalten, finde ich ein Einströmen des Atemwassers durch eine andere als die Milne-Edwardsche Öffnung (man sehe aber unter *Grapsus*). Weder in meinen Versuchen mit Chinesischer Tusche (mit der sich ziemlich schlecht arbeiten lässt), noch in den Versuchen mit Carmin, gelang es mir, eine Wasserbewegung an anderer Stelle sichtbar zu machen. Ebensowenig gelang es mir diese Bewegung zu demonstrieren durch die Strömungsrichtung kleinster Schmutzteilchen unter dem Mikroskop oder unter der Lupe. Ich sage nicht, dass es den Tieren unmöglich sein muss über dem letzten Thorakalfuss oder sogar mehr nach vorn Wasser aufzunehmen; denn die Hebung des Thorakalschildes, wie wir sie für *Sesarma* und *Grapsus* kennen lernen werden, kann ganz beträchtlich sein (vgl. auch unter *Grapsus*). Aber meine Beobachtungen scheinen mir darauf hinzuweisen dass die Tiere unter normalen Umständen das Thorakalschild unter Wasser „schliessen“. Schlitzförmige Öffnungen, die stets anwesend sind, und mit ihnen korrespondierende Eintrittsöffnungen an den Kiemenbasen, wie sie von LIM und BORRADAILE für *Carcinus moenas* beschrieben und abgebildet wurden, suchte ich an meinen Tieren vergebens; die Kiemen legen sich im Gegenteil, auch an ihren Basen, fest aneinander. Ich sage das deshalb so nachdrücklich, da ich anfangs selbst nicht glauben wollte, dass alle diese Arten sich in diesem Punkt von *Carcinus moenas* unterscheiden. Die Tiere, welche ich untersuchte, waren *Scylla serrata*, *Thalamita crenata*, *Sesarma taeniolata*, *meinerti* und *bataviana*, sowie zwei *Grapsus*-arten; weiter *Ilyoplax delsmanni* und *Metaplex elegans*. *Ocypode* und *Uca* bespreche ich weiter unten; sie verhalten sich abweichend.

Das aufgenommene Wasser gelangt in den sogenannten Hypobranchialraum BORRADAILLES. Es ist das Verdienst PEARSONS, darauf hingewiesen zu haben, dass die von ihm entdeckte branchial ridge die Scheidewand zwischen der In- und Exhalationsöffnung vervollkommnet. Die Wand wird dadurch gebildet, dass die Podobranchie des 2. Maxillipeds sich zwischen die branchial ridge und die Basen



der (bei *Carcinus* 2. bis 6.) Kiemen schiebt. Indem nun der Basalteil des Epipodits des 1. Maxillipeds sich fest gegen die Kieme legt, ist die direkte Kommunikation zwischen der In- und Exhalationsöffnung verbrochen. Fegt dieser Epipodit aber über die Kiemen (er dient zur Reinigung ihrer Oberseite), so kann das Wasser durch die genannte Podobranchie hindurch vom Scaphognathit angesogen werden bis die Epipodit-basis „das Gitter“ in der Wand wieder verschliesst. Hierauf wies BORRADAILE hin.

Das durch die Milne-Edwardsche Öffnung aufgenommene Wasser gelangt also in den Hypobranchialraum. LIM und BORRADAILE wiesen schon darauf hin, dass besonders die Lage der Kiemen diese Stromrichtung des Wassers beeinflusst. Das Wasser strömt durch den Hypobranchialraum nach hinten, tritt dabei zwischen den Kiemen hindurch nach oben und strömt darauf über die Kiemen nach vorn zurück, wo es in den Sammelraum (collecting space) BORRADAILES gelangt, aus dem der Scaphognathit es fortpumpt. Ich untersuchte das ausführlicher für die Süßwasserkrabbe *Potamon granulosus* DE MAN (siehe unten). Nähere Besonderheiten hierüber findet man für *Carcinus* im schönen Beitrag BORRADAILES. Bei *Potamon*, *Scylla*, *Thalamita*, *Cancer* und anderen Krabben verhält sich die Sache einfacher als bei *Carcinus*, da die Öffnungen über den Beinbasen fehlen; ich muss aber hinzufügen, dass ich mich des Eindrucks nicht erwehren kann, dass BORRADAILE sich die Sache für *Carcinus* zu kompliziert denkt.

In Tjibodas war ich in der Gelegenheit die da in den Gebirgsbächen vorkommende *Potamon granulosus* zu untersuchen. Wie bei vielen anderen Arten mit kleiner Kiemenzahl ist die Atemhöhle hier sehr geräumig. Dadurch kann man, ohne die Kiemen zu verletzen, ein Stück aus dem Dach der Atemhöhle ausschneiden. Das in dieser Weise entstandene Loch kann man darauf durch ein Deckgläschen, mittels Paraffin, wieder abschliessen. Es ist hierdurch möglich die Stromrichtung des Atemwassers zu studieren. — Bevor das Loch verschlossen ist, wird durch die Wirkung des Scaphognathits kräftig Wasser durch die herausgeschnittene Öffnung, gar nicht durch die Milne-Edwardsche Öffnung angesogen; wie begreiflich wird dieses Wasser durch die Exhalationsöffnung ausgepumpt. Nach Verschliessen des Lochs nimmt die Milne-Edwardsche Öffnung das Wasser wieder auf, wie das auch unter normalen Umständen der Fall ist. Durch das Deckgläschen hindurch kann man dabei leicht feststellen, dass Schmutzpartikelchen von hinten nach vorn über die Kiemen eilen, und zwar besonders die Aussenseite der Kammer entlang (Fig. 14). Es lässt sich aber nicht feststellen, wie diese Partikelchen die Oberseite der Kiemen erreichen: durch die Kiemen hindurch oder hinter den Kiemen herum.

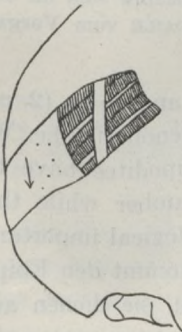


Fig. 14. Kiemenkammer von *Potamon granulosus* DE MAN, gesehen durch ein Fenster (Deckgläschen) im Thorakalschild. Kiemen, Epipodit des 1. Maxillipeds und Schmutzpartikelchen im Wasser.

Der Pfeil deutet die Strömungsrichtung des Wassers an. Das Auge der Krabbe ist unten.

Die Versuche mit Carmin bestätigen die Annahme BORRADAILES, dass der Epipodit des 1. Maxillipeds die direkte Verbindung zwischen der In- und Exhalationsöffnung verschliessen und freimachen kann. Sie zeigen nämlich das folgende.



Carmin, in die Milne-Edwardsche Öffnung eingebracht, kann:

1. für einen kleineren oder grösseren Teil gleich nach der Aufnahme durch die Exhalationsöffnung entfernt werden;
2. erst nach 2-3 Sekunden entfernt werden.

1. Wird es zum kleineren oder grösseren Teil (bisweilen ganz) sogleich entfernt, so nimmt es seinen Weg direkt von der In- zur Exhalationsöffnung. Es kommt dabei nämlich nicht an dem Fenster (Deckglas) vorbei und ist, wenn viel Carmin diesen Weg nimmt, bisweilen sichtbar im vordersten Teil der Kiemenkammer. — In meinen Versuchen schlug der Epipodit des 1. Maxillipeds viel hin und her und man hat sich vorzustellen, dass dadurch jedesmal für kurze Zeit der Zugangsweg im Borradaileschen Sinne geöffnet wurde. Die Kommunikation zwischen In- und Exhalationsöffnung bestand denn auch wirklich jedesmal nur kurze Zeit, denn nach dem Einspritzen des Carmins kam meistens nur ein wenig Carmin sogleich heraus, während dann nach 2-2.5 Sekunden der übrige Carmin nachkam. Es ist mir aber nicht gelungen bei diesen Versuchen den Zusammenhang zwischen seitlicher Epipoditliegeung und Abschlüssung des Zugangswegs zu beweisen, wodurch wir in dieser Beziehung Gewissheit haben würden.

2. Nimmt der Carmin den normalen Weg, so kann man ihn durch die Kiemen hindurch nach hinten bewegen sehen, da er den Kiemenkammerboden etwas rosa verdunkelt. Er befindet sich dabei also im Hypobranchialraum. Nach ungefähr zwei Sekunden erreicht er, durch die Kiemen hindurch, die Oberseite der letzteren. Darauf wird er mit grosser Schnelligkeit nach vorn gesogen. Ich konnte dabei nicht feststellen, dass er mehr nach vorn etwas früher die Kiemenoberfläche erreicht als mehr nach hinten, das muss aber der Fall gewesen sein, da man ihn unter den Kiemen so deutlich sich nach hinten bewegen sieht.

Einmal konnte ich feststellen, wie das Carminwasser, das über den Kiemen nach vorn strömte, eher sichtbar war als das Wasser, das durch die Kiemen hindurch die Oberfläche erreichte. Dies kann ich mir nur dadurch erklären, dass das Wasser auf dem Wege hinter den Kiemen herum schneller oben war als das Wasser, das zwischen den Kiemen hindurch seinen Weg nahm. Auf letzterem Wege begegnet es dem Widerstand der Reibung, der hinten fehlen kann, wenn der Thorakalschild sich da hebt.

Wie man sieht, stimmt alles mit der Vorstellung, die BORRADAILE vom Vorgang gab, schön überein <sup>1)</sup>.

Die Epipodite der 1., 2. und 3. Maxillipede, die oben (1.) und unten (2. und 3.) über die Kiemen fegen, dienen zur Reinhaltung der Kiemenoberfläche. Wie BORRADAILE bemerkt: "No doubt the movements of the epipodites have the effect of mingling and distributing the water in the gillchamber while they clean the gills, but it is not clear that this has any such physiological importance as has been attributed to it" (p. 134). Meiner Meinung nach kommt den Epipoditen sogar gar keine Bedeutung für die Wasserverteilung zu, sie dienen ausschliesslich der Reinigung.

BORRADAILE gibt für den Epipodit des 1. Maxillipeds an: "It is probably

<sup>1)</sup> Während dieser Arbeit machte ich eine merkwürdige Beobachtung. Nahm ich die Krabbe aus dem Wasser heraus, so konnte ich durch das Fenster sehen wie nach kurzer Zeit die hinteren 4 Kiemen nach hinten, die vorderen 3 (2½) nach vorn kontrahiert wurden (Fig. 15 und 16). Offenbar wurde dies von Muskeln an der Kiemenbasis gemacht. Dann und wann schoben sich die Kiemen wieder in ihre normale Haltung zurück, wie ein Schiebevorhang; darauf wurden sie wieder nach hinten und vorn gezogen. Durch diese Bewegung kam der Eintritt zur Kiemenkammer durch die Milne-Edwardsche Öffnung, sowie der Epipodit des 3. Maxillipeds und ein Teil des Kiemenkammerbodens frei zu liegen.



moved more by the action of its own powerful muscles than by the excursions of the maxilliped as a whole"; für die beiden folgenden Epipodite gibt er aber an, dass sie hauptsächlich passiv, durch die Bewegungen der betreffenden Coxalglieder, bewegt werden. Ich sagte aber schon, dass bei *Sesarma*, *Grapsus*, *Metaplatz*, *Uca*, u.a. die Epipodite der 3. Maxillipede — wie aus der Bewegung ihrer Basalteile ersichtlich — unabhängig vom Endopodite rhythmisch hin und her bewegen. Wie gesagt dient diese Bewegung der Entfernung von Schmutz in oder über der Milne-Edwardschen Öffnung.

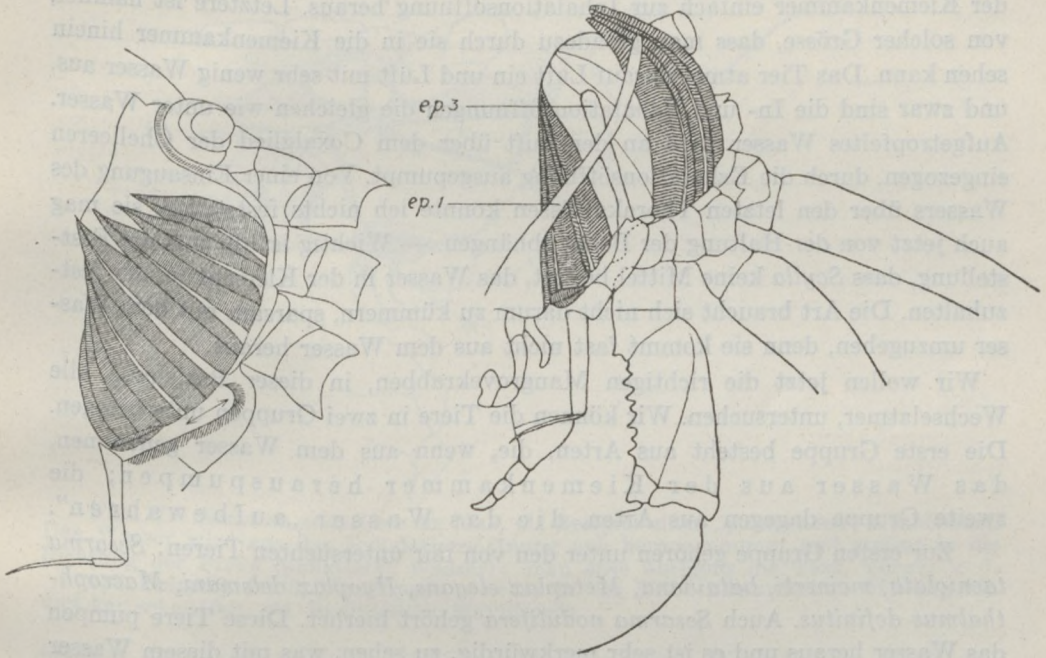


Fig. 15 und 16. Vgl. Fussnote S.228. Der doppelte Pfeil der Figur 15 deutet die Breite der Milne Edwardschen Öffnung an; in Figur 16 sind der Epipodit des 1. und 2. Maxillipeds, sowie der 2. und 3. Maxilliped selbst, mit eingezeichnet. — Vergr.  $\times 1\frac{1}{4}$ .

Die Exopodite der Maxillipede, welche in vielen (allen?) Arten blitzschnell schlagen können (meistens abwechselnd links und rechts, und alle drei zusammen) sollen nach BOHN (1899), PEARSON und BORRADAILE die Wirkung des Scaphognathits unterstützen. Diese Unterstützung spielt aber (wie BOHN auch bemerkt) nur in soweit eine Rolle als die Flagellen das Wasser, welches sich vor dem Tier befindet, nach links (linke Flagellen) oder nach rechts (rechte Flagellen) schlagen, wodurch eine Strömung vor dem Tier entsteht, die nur sekundär Wasser aus dem Exhalationskanal ansaugt. Diese Strömung hat besonders für die Riechfunktion der Antennen Bedeutung, wie von BROCK für Paguriden gezeigt wurde; weiter entfernt sie das gebrauchte Wasser aus der Umgebung der Krabbe. Man sehe besonders BROCK, p. 488 - 489.

Über die Umkehrung der normalen Atembewegungen sehe man bei GARSTANG,



BOHN (1897b), BABAK und BORRADAILE. Ich konnte mich an einigen Arten (*Scylla*, *Potamon*, u.a.) davon überzeugen, dass die Umkehrung — wie auch bekannt — der Entfernung von Schmutzpartikelchen aus der Kiemenhöhle dient.

Bis so weit über die Atmung der unter Wasser gehaltenen Tiere. Ganz anders verhält sich die Sache, sobald man die Tiere aus dem Wasser herausnimmt und die Luftatmung studiert. Ich fange wiederum mit *Scylla*, als Wasserkrabbe, an. — Nimmt man *Scylla* aus dem Wasser heraus, so läuft ein Teil des Wassers der Kiemenkammer einfach zur Inhalationsöffnung heraus. Letztere ist nämlich von solcher Grösse, dass man geradezu durch sie in die Kiemenkammer hinein sehen kann. Das Tier atmet darauf Luft ein und Luft mit sehr wenig Wasser aus, und zwar sind die In- und Exhalationsöffnungen die gleichen wie unter Wasser. Aufgetropftes Wasser wird an der Luft über dem Coxalglied der Cheliceren eingezipst, durch die Exhalationsöffnung ausgepumpt. Von einer Einsaugung des Wassers über den letzten Thorakalfüssen konnte ich nichts feststellen, sie mag auch jetzt von der Haltung der Beine abhängen. — Wichtig ist für uns die Feststellung, dass *Scylla* keine Mittel besitzt, das Wasser in der Kiemenkammer festzuhalten. Die Art braucht sich nicht darum zu kümmern, sparsam mit dem Wasser umzugehen, denn sie kommt fast nicht aus dem Wasser heraus.

Wir wollen jetzt die richtigen Mangrovekrabben, in dieser Beziehung alle Wechselatmer, untersuchen. Wir können die Tiere in zwei Gruppen unterbringen. Die erste Gruppe besteht aus Arten, die, wenn aus dem Wasser genommen, das Wasser aus der Kiemenkammer herauspumpen; die zweite Gruppe dagegen aus Arten, die das Wasser „aufbewahren“.

Zur ersten Gruppe gehören unter den von mir untersuchten Tieren: *Sesarma taeniolata*, *meinerti*, *bataviana*, *Metaplex elegans*, *Ilyoplax delsmanni*, *Macrophthalmus definitus*. Auch *Sesarma nodulifera* gehört hierher. Diese Tiere pumpen das Wasser heraus und es ist sehr merkwürdig, zu sehen, was mit diesem Wasser geschieht. Es fliesst, da es durch die Retikulation und Gruben des Körpers gelenkt wird, nach unten, und wird, teils durch die Inhalationsöffnung, teils mehr nach hinten, wieder aufgenommen. Diese Atmungsmechanik wurde für *Sesarma* von MÜLLER beschrieben (s. unten); dadurch, dass sie eine grössere Verbreitung hat als bis jetzt bekannt war, können wir sie der Atmungsmethode der Tiere der zweiten Gruppe gegenüberstellen.

Zur zweiten Gruppe gehören unter den von mir untersuchten Arten: zwei *Grapsus*-arten, *Uca consobrinus* und *signatus* und eine *Ocypode*-art. Auch *Potamon granulatus* gehört hierher. Diese Tiere pumpen kein Wasser heraus; während der Ausatmung der aufgenommenen Luft wird nur ganz wenig Atemwasser fortwährend mit nach aussen befördert. Es bestehen keine bestimmten Wege für dieses Wasser, das würde auch nicht der Mühe lohnen; was austritt ist verloren.

Die beiden hier behandelten Gruppen stellen sich *Scylla* gegenüber, indem sie sparsam mit dem Wasser umgehen, von einer geräumigen Inhalationsöffnung über dem Chelipedbasis, wie bei *Scylla*, ist keine Rede. Die Angehörigen der



ersten der beiden Gruppen pumpen das Wasser zwar fortwährend heraus, pumpen es aber darauf wieder ein; die Tiere der zweiten Gruppe pumpen sozusagen Luft durch das Wasser hindurch.

ERSTE GRUPPE (Fig. 17). — *Sesarma* c.s. pumpt das Wasser der Kiemenkammer heraus. Es strömt über den Körper des Tieres und muss dabei Luft auf-

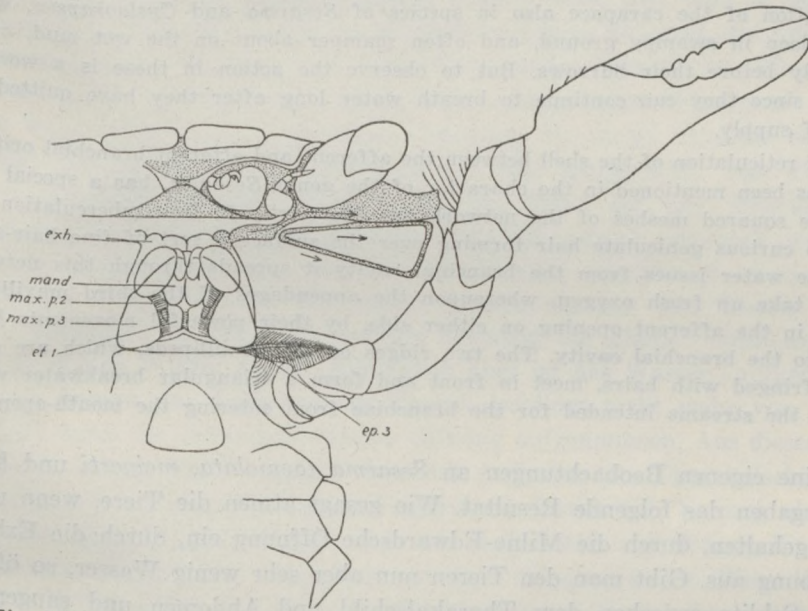


Fig. 17. *Sesarma nodulifera* DE MAN, als Beispiel einer „pumpenden“ Krabbenart. Das Wasser wird aus der Exhalationsöffnung exh herausgepumpt und strömt in die Richtung der Pfeile (punktiert: Wasser); man sehe übrigens die Text. Vergr.  $\times 7$ . ep3 Epipodit des 3. Maxillipeds, welcher in der Milne-Edwardschen Öffnung hin und her schaufelt, et1 Endit des 1. Maxillipeds.

nehmen. Das aerierte Wasser wird wieder eingeatmet. Wie effektiv der Kreislauf des Wassers ist, geht daraus hervor, dass *Sesarma taeniolata* an der Luft mehr als 9 Stunden (siehe weiter unten) Wasser pumpen kann. Während dieser Zeit wird also fast keine blosse Luft eingeatmet.

Beobachtungen über die merkwürdige Atmungsbewegungen von *Sesarma* scheinen nur von MÜLLER (1863) gemacht worden zu sein. Sie wurden in BRONN (ORTMANN, p. 1036), Cambridge Natural History (p. 195) und WINTERSTEIN (BABAK, p. 350, 353) aufgenommen, aber die ausführlichste Wiedergabe der MÜLLERSchen Wahrnehmungen (die ich in Batavia nicht in originali einsehen kann) finde ich in STEBBING (p. 97 - 98):

“In the family Grapsidae he describes, under the name *Aratus Pisonii*, the species which Milne-Edwards calls *Sesarma Pisonii*, a sweet little vivacious crab, which climbs the mangrove-bushes and feeds upon their leaves. Its short sharp claws are well fitted for climbing, but they prick like pins when the creature runs over a bare hand. Once, when he had one of these seated on his hand, FRITZ MÜLLER noticed that it raised up the hinder part of its carapace, and that by this means a wide slit was opened on each side over the last pair of feet, affording a view into the branchial



cavity. When studying this phenomenon in another species, which he took to be a true *Grapsus* (*messor*?, vide WINTERSTEIN, p. 353), he observed that with the formation of the slit behind the anterior part of the carapace seems to sink so as partly or entirely to close the anterior afferent opening. As the lifting of the carapace never takes place under water, he infers that the animal opens its branchial cavity in front or behind according as it requires to breathe water or air. He had noticed the elevation of the carapace also in species of *Sesarma* and *Cyclograpsus*, which burrow deep in swampy ground, and often scamper about on the wet mud, or sit watchfully before their burrows. But to observe the action in these is a work of patience since they can continue to breathe water long after they have quitted the source of supply.

That reticulation of the shell between the afferent and efferent branchial orifices, which has been mentioned in the character of the genus *Sesarma*, has a special purpose. The squared meshes of the network are due partly to fine tuberculation and partly to curious geniculate hair forming over the surface a sort of fine hair-sieve. When the water issues from the branchial cavity it spreads through this network, and can take up fresh oxygen, whereupon the appendages of the third maxillipeds working in the afferent opening on either side, by their powerful movements bring it back to the branchial cavity. The two ridges on the maxillipeds, which are often densely fringed with hairs, meet in front and form a triangular breakwater which prevents the streams intended for the branchiae from entering the mouth-opening".

Meine eigenen Beobachtungen an *Sesarma taeniolata*, *meinerti* und *bata-viana* ergaben das folgende Resultat. Wie gesagt atmen die Tiere, wenn unter Wasser gehalten, durch die Milne-Edwardsche Öffnung ein, durch die Exhalationsöffnung aus. Gibt man den Tieren nun aber sehr wenig Wasser, so öffnen sie den Schlitz zwischen dem Thorakalschild und Abdomen und saugen da Wasser ein. Karmin wird mit grosser Kraft hierher gesogen. Das Wasser strömt zur Exhalationsöffnung heraus. Ein Teil dieses Wassers nimmt seinen Weg nach oben und fliesst über den Rücken nach hinten herab; ein Teil fliesst durch Gruben seitwärts und dieses Wasser scheint über das retikulierte Seitenfeld nach unten und hinten zu fliessen; ein Teil fliesst nach unten, strömt zur Aussen-seite der 3. Maxillipede und über den vorderen Teil des retikulierten Feldes nach unten, wird darauf wohl grossenteils durch die Milne-Edwardsche Öffnung aufgesogen werden.

Den Lauf des Wassers habe ich für die kleine *Sesarma nodulifera*, soweit mir das allerdings möglich war, in Bild gebracht (Fig. 17). Das aus der Exhalationsöffnung herausgepumpte Wasser wird durch Gruben zu der Umgebung der Augensiele und der Antennen, nach unten zum retikulierten Felde geleitet. Die Gruben und Kanäle verlaufen so, dass das Wasser auch auf den Rücken gepumpt wird, wobei es über den Carapax nach hinten strömt. Man kann diese schwache Strömung mit Carmin sichtbar machen. Das Wasser, das über das retikulierte Feld fliesst, wird wahrscheinlich durch die Milne-Edwardsche Öffnung und hinten, das Wasser des Rückenschildes wahrscheinlich grossenteils hinten (siehe unten) aufgenommen.

Die Angabe MÜLLERS, dass der Epipodit des 3. Maxillipeds (ich nenne ihn „die Schaufel“) zur Einsaugung des Wassers dienen würde, ist unrichtig. Wir wissen schon, dass diese kontinuierliche Epipoditbewegung der Entfernung von Schmutzpartikelchen dient. Auch die Angabe, dass der Carapax, wenn er sich hinten hebt, sich vorn senkt und da die Milne-Edwardsche Öffnung verschliesst, ist unrichtig.



Um im Stande zu sein, in dem ganz flachen Wasser hinten Wasser aufzusaugen, drückt die Krabbe sich mit dem Hinterteil des Körpers fest gegen den Boden. Nimmt man dem Tier nun völlig alles Wasser, so wird in genau der gleichen Weise wie vorher das Wasser der Kiemenkammer zur Exhalationsöffnung herausgepumpt. Es fließt in der oben beschriebenen Weise über den Körper des Tieres, der dabei ausgiebig benetzt wird, und wird in genau der gleichen Weise wie oben durch die Milne-Edwardsche Öffnung und hinten wieder aufgenommen. Während die Milne-Edwardsche Öffnung das Wasser fortwährend aufnimmt, findet die Aufnahme des ausgepumpten Wassers am hinteren Ende wahrscheinlich nur jede soviel Sekunden bis soviel Minuten statt. Die Krabbe hält nämlich den Thorakalschild fest angedrückt; hat sich aber hinten ein wenig Wasser angesammelt, so lüftet sie den Thorakalschild hinten (meistens hauptsächlich entweder links oder rechts), wodurch der Schlitz zwischen dem Schild und Abdomen freikommt, und saugt durch diesen Schlitz das Wasser ein. — Wie gesagt können die aus dem Wasser genommenen *taeniolata* an der Luft mehrere Stunden, die kleinen *bataviana* mehr als eine Stunde Wasser atmen. Allmählich aber ist das Wasser „aufgebraucht“ und nun kommt das Aufheben des Thorakalschildes nicht mehr vor, es wird nur Luft durch die Milne-Edwardsche Öffnung aufgenommen. Aus diesen Beobachtungen scheint hervorzugehen, dass das Aufheben des Thorakalschildes die Aufnahme des vorn ausgepumpten Wassers zum Zweck hat. Es mag aber auch sein, dass diese Annahme falsch, dass das Aufnehmen von Wasser hinten nur Nebensache, dagegen eine Aufnahme von Luft Hauptsache ist. Wenn das Tier später aufhört den Carapax hinten zu öffnen, so könnte das den Zweck haben einer Austrocknung der Kiemenhöhle vorzubeugen. Die Angabe MÜLLERS aber, die Krabbe schliesse, beim Heben des Schildes hinten, die Milne-Edwardsche Öffnung ab, und sie atme vorn nur Wasser ein, ist falsch. Die Atmung von *Sesarma* beantwortet in dieser Hinsicht dem gewöhnlichen Schema, das wir weiter unten besser kennen lernen werden. Ich habe noch zuzufügen, dass nicht nur ganz hinten Aufnahme des Wassers stattfindet, dass auch über den Basen der 5. und 4. Beine der Branchiostegitrand gehoben wird. — Während die Hebung des Thorakalschildes, welche zur Wasser- oder Luftaufnahme dient, ziemlich ansehnlich und ganz auffallend ist, genügt der gewöhnliche Stand des Thorakalschildes für die luftatmende Krabbe, nachdem diese das Atemwasser aufgebraucht hat, um Luft einzunehmen. Man erkennt das erstens an der rhythmischen Bewegung der feuchten Haarbekleidung. Zweitens aber werden Wassertropfen, die man den Basen der 5. Beine oder dem hinteren Schlitz nähert, gierig aufgenommen, die Exhalationsöffnung produziert, indem das Wasser sich der Luft beimischt, wieder Luftblasen, schliesslich wirft sie wieder Wasser aus.

Als Resultat ergibt sich also: *Sesarma* atmet unter Wasser durch die Milne-Edwardsche Öffnung, in seichtem Wasser oder ausserhalb des Wassers durch diese und hinten am Körper ein.

Genau die gleichen Verhältnisse fand ich, wie gesagt, bei *Sesarma nodulifera*, *Ilyoplax delsmanni*, *Metaplex elegans* und *Macrophthalmus definitus*. Auch diese



Arten pumpen, aus dem Wasser genommen, lange Zeit Wasser heraus und dieses Wasser strömt auch hier über den Rücken, u.s.w. Alle diese Arten zeigen retikulierte Seitenfelder wie *Sesarma*, oder jedenfalls eine Struktur, die die gleiche Funktion als die Felder von *Sesarma* zu erfüllen scheint. Die geringere Grösse von einigen dieser Arten macht die Beobachtung schwieriger als bei der grossen *Sesarma taeniolata*; ausserdem untersuchte ich *Macrophthalmus* nur kurz; es scheint aber (ich bin nicht ganz sicher), dass mindestens *Ilyoplax* und *Metaplex*, wenn sie aus dem Wasser genommen werden, den Thorakalschild hinten heben, wie *Sesarma* das macht.

ZWEITE GRUPPE (Fig. 18): *Grapsus* und *Uca* pumpen, wenn aus dem Wasser genommen, kein Wasser aus. Es geht nur sehr wenig Wasser verloren; drückt man auf den Branchiostegit einer *Uca*, die lange an der Luft geatmet hat, so wird immer noch Wasser ausgepresst und es entstehen Luftblasen. Es muss also Luft durch das Wasser hindurch geführt werden.

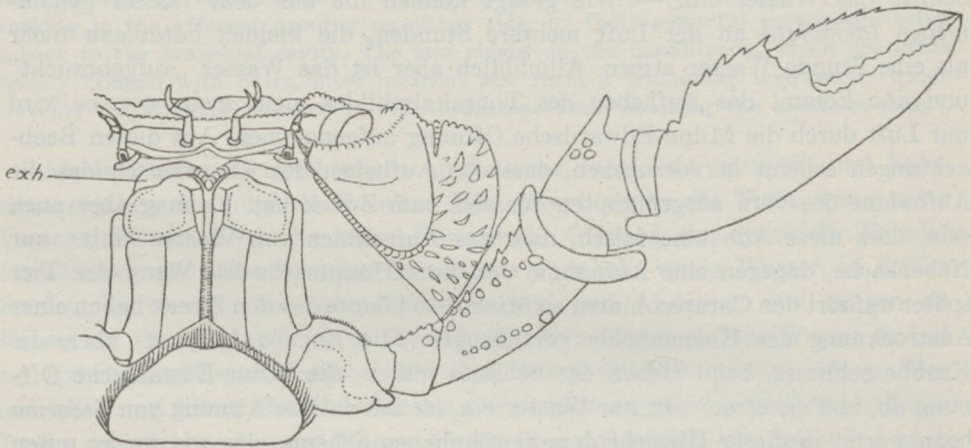


Fig. 18. *Potamon granulatus*, als Beispiel einer nicht-pumpenden Krabbenart. Gruben für das Wasser fehlen. — An den Basen der 2. Antennen sind die Öffnungen der Antennendrüsen sichtbar. Die 3. Maxillipede verschliessen die Mundteile ganz, während sie das bei *Sesarma* u.a. (Fig. 17) nicht tun. — Vergr.  $\times 1\frac{1}{2}$ .

*Grapsus* und *Uca*, obgleich beide zur Gruppe der Nichtpumper gehören, unterscheiden sich in anderer Hinsicht auffallend. *Grapsus* hat mit der Grapside *Sesarma* das Lüften des Thorakalschildes gemein; dies zeigt diese Art sogar noch mehr als *Sesarma* <sup>1)</sup>. *Uca* dagegen, als richtige *Ocypode*, hat mit den *Ocypode*-arten eine Einatmungsöffnung zwischen dem 3. und 4. Thorakalfuss gemein. Wir haben *Grapsus* und *Uca* also gesondert zu besprechen.

A. An *Grapsus*-arten untersuchte ich *Grapsus strigosus* HERBST und *Metopograpsus latifrons* WHITE (vielleicht diese Art oder *M. pictus* A. MILNE-EDW.). Unter Wasser findet bei beiden Arten die Wasseraufnahme durch die Milne-Edwardsche Öffnung statt, während das Wasser durch die Exhalationsöffnung aus-

<sup>1)</sup> Das Heben des Thorakalschildes kommt ebenso bei *Potamon granulatus* vor, der, was das Nichtpumpen anbetrifft, ebenso zur zweiten Gruppe gehört.



strömt und hinten der Thorakalschild den Zugang verschliesst. Die Atmung von *Grapsus* unter Wasser entspricht also dem gewöhnlichen Schema.

Ein Exemplar von *latifrons* oder *pictus*, das einige Zeit an der Luft gehalten war und darauf in ein Gefäss mit Wasser gesetzt wurde, schloss den Rückenschild anfangs hinten nicht ab, und atmete deshalb hinten Karmin ein, der zur Exhalationsöffnung herausgeworfen wurde. Darauf wurden die hinteren Öffnungen [zwei weite langgestreckte Öffnungen über den Basen der 5. (auch der 4.?) Beine] durch Andrücken des Rückenschildes verschlossen und das Tier atmete nur durch die Milne-Edwardsche Öffnung ein. Das war das einzige Mal — wenn ich von *Ocypode* und *Uca* absehe — dass ich eine unter Wasser gehaltene Krabbe hinten Wasser aufnehmen sah.

Aus dem Wasser genommen zeigt *Grapsus* eine Einatmung durch die Milne-Edwardsche Öffnung, eine Ausatmung durch die Exhalationsöffnung und hinten, über den Basen der 4. und 5. Beine. Ich bekam den Eindruck, dass die Ausatmungen hinten und vorn mit einander an Stärke mehr oder weniger deutlich abwechselten und dass eine sehr deutliche Ausatmung hinten mit einer Einatmung durch die Exhalationsöffnung und umgekehrt zusammenging. Bisweilen wurde aber sowohl vorn wie hinten ausgeatmet. Exemplare von *Metopograpsus latifrons* öffneten, aus dem Wasser genommen, hinten den Rückenschild, genau wie *Grapsus strigosus*, und dabei wurde durch die Milne-Edwardsche Öffnung ein-, durch die Exhalationsöffnung ausgeatmet, während hinten meist ein-, bisweilen ausgeatmet wurde. Aus diesen Beobachtungen an *Grapsus* geht also hervor, dass die studierten Arten unter Wasser vorn ein-, und vorn ausatmen, über dem Wasser hinten und durch die Exhalationsöffnung sowohl aus- wie einatmen können.

B. *Uca* besitzt eine Öffnung zwischen dem 3. und 4. Beinpaar. Diese Öffnung findet sich in gleicher Weise bei *Ocypode*, die, der Grösse wegen, viel bequemer untersucht werden kann. Wir verdanken MÜLLER eine ausführliche Beschreibung dieser Öffnung, und zwar die von *Ocypode rhombea* FABRICIUS. Ich finde sie in STEBBLING, p. 86-87 (vide ORTMANN, p. 1036-1037, BABAK, p. 251-252).

"In the swift-footed Sand-crabs (*Ocypoda*)" he says, "which are exclusively land animals, that can scarcely live in water for a single day, and which in far less time than that are reduced to a state of complete collapse in which all voluntary movements cease—there has long been known a peculiar arrangement connected with the third and forth pairs of legs, but that these had anything to do with the branchial cavity was not suspected. These two pairs pressed more closely together than the rest. The opposed surfaces of their basal joints, that is, the hinder surface in the third, and the front surface in the forth pair, are flat and smooth, and their margins are closely fringed with long, sheeny, peculiarly formed hairs. MILNE-EDWARDS, who compares them to articular surfaces as their appearance warrants, thinks that they serve to diminish the friction between the two legs. On this supposition the question arises why precisely in these crabs and only between these two pairs of legs such a provision for diminishing friction is necessary, not to mention that it leaves unexplained the singular hairs, which must augment instead of diminishing friction. While, then, I was bending to and fro in ever so many directions the legs of a large Sand-crab, in order to see in what movements of the animal friction occurred at the place in question, and whether perhaps these were movements often recurring and of special



importance to it, I observed, when I had stretched the legs far apart, a round opening of considerable size between their bases, through which air could easily be blown into the branchial cavity or even a slender probe be introduced. The aperture opens into the branchial cavity behind a conical tubercle, which stands above the third foot at the place of a branchia which is wanting in *Ocypoda*. It is laterally bounded by ridges which rise above the articulation of the legs and to which the lower edge of the carapace is applied. Also outwardly it is overarched by these ridges with the exception of a narrow slit. Over this slit extends the carapace, which just at this point projects further downwards than elsewhere, and so a complete tube is formed. While *Grapsus* always admits water to its branchiae only from in front, in *Ocypode* I saw it also streaming in through the just described aperture."

Ich brauche der ausführlichen Beschreibung nichts beizufügen, höchstens dass sich da, wo der Carapax "projects further downwards than elsewhere", ein Büschel Haare am Carapax befindet, welches den „slit" bedeckt, wie

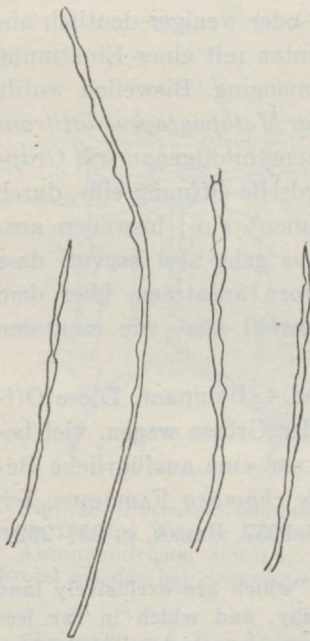


Fig. 19. Haare, welche die Müllersche Öffnung von *Ocypode ceratophthalma* begrenzen. Vergr.  $\times 50$ .

BORRADAILE das für die Öffnungen über den Beinbasen von *Carcinus moenas* beschreibt. Die von MÜLLER genannten "long, sheeny, peculiarly formed hairs" ähneln keinem der von MCINTOSH für *Carcinus moenas* abgebildeten Haartypen (vgl. Fig. 19). Die Angaben über diese Atmungsöffnung, welche sich in der Literatur finden, scheinen alle auf diesen Angaben MÜLLERS zu fassen. Ich nenne die genannte Öffnung die MÜLLERSche. Was nun die Funktion dieser Öffnungen bei *Ocypode rhombea* anbelangt, gibt MÜLLER also an, dass er durch sie Wasser einströmen sah. Ich untersuchte alte und junge Exemplare von *ceratophthalma*. Unter Wasser atmeten die alten Exemplare stets stark durch die Müllersche Öffnung ein <sup>1)</sup>, während durch die Exhalationsöffnung ausgeatmet wurde. Dabei wurde durch die Milne-Edwardsche Öffnung bisweilen ein-, bisweilen ausgeatmet, bisweilen war diese Öffnung ganz verschlossen. Junge Exemplare dagegen zeigten unter Wasser Einatmung durch die Milne-Edwardsche, Ausatmung durch die Exhalationsöffnung; eine Einatmung durch die Müllerschen

Öffnungen kommt vielleicht weniger vor. — Gleiches Verhalten wie bei *Ocypode* finden wir nun bei *Uca*. Ich untersuchte *signatus* und *consobrinus*. Es wurde unter Wasser durch die Milne-Edwardsche Öffnung oder durch diese und die Müllersche Öffnung ein-, durch die Exhalationsöffnung ausgeatmet. Man bekommt bei diesen Beobachtungen den Eindruck dass alte *Ocypode ceratophthalma* bei fast jedem Beinstand durch die Müllersche Öffnung einatmen, während

<sup>1)</sup> Sie kann bei bestimmter Beinlage verschlossen sein, normal geschieht das aber offenbar nie.



*Uca* dazu erst die Beine heben muss: ich konstatierte hier nur Einatmung durch die Müllerschen Öffnungen während der Hebung der 4. oder der 4. und 5. Beine. Vielleicht spielt die Grösse der Müllerschen Öffnungen bei alten *Ocypode ceratophthalma* die ausschlaggebende Rolle.

Ausserhalb des Wassers fand ich bei alten *ceratophthalma* Einatmung durch die Müllersche Öffnung, Ausatmung durch die Exhalationsöffnung und Milne-Edwardsche Öffnung beide, meistens entweder durch eine oder die andere, bisweilen durch beide zugleich. Aber ich nahm auch Einatmung durch die Milne-Edwardsche Öffnung, Ausatmung durch die Exhalations- oder Müllersche Öffnung oder durch beide zugleich wahr. Bei jungen *ceratophthalma* nahm ich nur wahr dass Milne-Edwardsche und Müllersche Öffnungen beide inhalierend wirkten, dass durch die bekannte Exhalationsöffnung ausgeatmet wurde. Es gelang mir nicht die Atmungsrichtung von ausserhalb des Wassers gehaltenen *Uca* festzustellen, die Tiere sind zu klein; wir dürfen aber annehmen dass die Atmung mit der von *Ocypode* übereinstimmt <sup>2)</sup>).

Wenn bei *Ocypode* und *Uca* durch die Müllersche Öffnung inhaliert und durch die Exhalationsöffnung ausgeatmet wird, ist der Unterschied zwischen dem Inhalieren und Exhalieren durch die Milne-Edwardsche Öffnung offenbar unwesentlich. Gleiches gilt in bezug auf In- oder Exhalieren durch die Müllersche Öffnung. Das gleiche sehen wir bei *Grapsus*. Wenn da vorn ein- und vorn ausgeatmet wird, ist es ziemlich einerlei, ob hinten ein- oder ausgeatmet wird. Man wird hierdurch versucht, anzunehmen, dass im ersten Fall die Milne-Edwardsche, im zweiten Fall die Müllersche Öffnung einen „Überschuss“ produziert im Vergleich zur Abfuhr. Da aber der Scaphognathit als Saugorgan an der Abfuhrstelle wirkt, ist das unmöglich.

Zusammenfassend können wir die untersuchten Krabben nach ihrer Atmung also wie folgt einteilen:

- |   |  |
|---|--|
| 1. Wasserkrabben. Grosse Inhalationsöffnung.<br>Schwimmkrabben <i>Scylla</i> , <i>Nep- tunus</i> , <i>Thalamita</i> . | 2. Wechselatmer. Kleine Inhalationsöffnung.<br>I. Pumper: <i>Sesarma</i> , <i>Ilyoplax</i> , <i>Metaplax</i> , <i>Macrophthalmus</i> .<br>II. Nichtpumper.<br>a. normal: <i>Grapsus</i> , <i>Potamon</i> .<br>b. Öffnung zwischen den Basen der 3. und 4. Beine: <i>Uca</i> , <i>Ocypode</i> . |
|---|--|

Alle von mir untersuchten Arten, ausser *Ocypode* und *Uca*, stimmen darin überein, dass sie unter Wasser vorn ein- und vorn ausatmen, während im all-

<sup>2)</sup> Eine beachtenswerte Angabe über die Atmung junger *Uca pugilator* von 4 mm Carapaxbreite nach HYMAN (1922, p. 458). „The carapace shows the square box shape of the adult, and on the area around the mouth-parts there are developed brushy hairs on which the water that is driven out of the gill chamber may be aerated before it is sucked in again. This makes the little crab more independent of the moisture of the immediate water's edge and he may wander about more freely on the beach“. Diese Beschreibung passt auf die Atmung des *Sesarma- typus*.



gemeinen ausserhalb des Wassers auch hinten eingeatmet wird. Und *Ocypode* und *Uca* die auch unter Wasser hinten eine Einstömungsöffnung können funktionieren lassen, stimmen wahrscheinlich mit den anderen darin überein, dass sie diese Öffnung mehr ausserhalb als unterhalb des Wassers benutzen.

Es bleiben nun noch einige Besonderheiten zur näheren Besprechung.

#### 1. DIE ATMUNG DER OCYPODEN (*UCA*, *OCYPODE*).

*Uca* ist Landtagtier und liebt die brennende Sonnenhitze. Dennoch zeigt die Art Kiemenatmung. JOBERT (1875) hat indirekt angegeben, dass sie ohne Wasser leben kann. Nimmt es da Wunder, wenn uns ihre Atmung rätselhaft erscheint?

JOBERT hat mitgeteilt dass mehr als 200 Stück des Gecarciniden *Ucides cordatus* (L.), die nach ihm zwei, vier und sechs Tage „dans un lieu privé de toute humidité“ gehalten wurden, am Leben blieben. Weiter gab er an, dass die Tiere, nachdem sie drei Tage unter Wasser gehalten waren, noch Luft in der Kiemenkammer hatten. Er beschrieb weiter die Verteilung der Gefässe in der Kiemenkammerwand und sagte dann, dass gleiche Verhältnisse wie bei *Ucides* sich bei *Cardisoma*, *Uca*, *Grapsus*? und *Dilocarcinus* finden. Leider kann ich in Batavia den ausführlicheren zweiten Beitrag JOBERTS nicht einsehen. Jedenfalls aber werden hier bestimmte Beobachtungen in nicht zu billiger Weise verallgemeinert.

Lässt man *Uca* (ich arbeitete mit *signatus* und *consobrinus*) kurze Zeit (einige Minuten genügen) im Wasser und öffnet dann unter Wasser den Thorakalschild, so findet man keine Spur von Luft; alle Luft entweicht sobald die Tiere unter Wasser zu atmen anfangen. Nimmt man die Tiere mit der mit Wasser gefüllten Kiemenkammer aus dem Wasser heraus und setzt sie an einer trockenen Stelle in ein trockenes offenes Gefäss (natürlich aus der Sonne), so leben sie höchstens ungefähr 10 Stunden; nach dieser Zeit sind sie völlig ausgetrocknet. Es kommt also an erster Stelle darauf an, dass die Tiere feucht bleiben. Ich habe denn auch schon gesagt, dass sie regelmässig, nur zu ihrer Befeuchtung, das Wasser aufsuchen.

Das gleiche gilt für *Ocypode*. Die Tiere dieses Genus zeigen 6-7 Kiemen an jeder Seite. Dennoch geben SMITH (Cambridge Nat. History, p. 194) und BABAK (WINTERSTEIN, p. 352) an, dass die Kiemen völlig fehlen („verschwunden sind“ ist der beliebte Ausdruck). In mehreren Büchern und Beiträgen kann man lesen, dass *Ocypode* nie das Wasser aufsucht und darin bald ertrinkt, Angaben die alle auf der Beschreibung MÜLLERS fussen (man sehe S.235). COWLES hat aber schon 1908 (p. 32-33) für *Ocypode arenaria* mitgeteilt, dass die Art regelmässig das Wasser aufsucht, dass sie nur kurze Zeit ohne Wasseraufnahme an der Luft leben kann und dass sie im Wasser nicht stirbt. <sup>1)</sup>

<sup>1)</sup> HARMS (p. 306) sagt: „Die Ocypoden vertragen ein Untertauchen in Seewasser nur wenige, 6-12, Stunden, wie auch schon BORRADAILE feststellte“. Aus dieser Angabe scheint hervorzugehen dass er selbst Versuche anstellte. Da er diese Versuche aber nicht beschreibt, lässt sich nicht feststellen, ob auf den Sauerstoffgehalt des Versuchswassers geachtet wurde. Die Angaben BORRADAILES kann ich in Batavia nicht zu Gesicht bekommen.



"Of 10 specimens placed in the sun in a wooden tub all but 3 had died after 4 hours' exposure. Other specimens kept in a dry aquarium in the laboratory and not exposed to the direct sunlight lived almost 24 hours. Although *Ocypoda* can probably not live over 24 hours in a dry place, it remains alive much longer in damp sand".

"When undisturbed, *Ocypoda* goes down to the ocean now and then in order to moisten its gills with fresh seawater; but at these times the individuals do not enter the water; they settle down about 6 or 8 inches from the water-line formed by medium-sized waves, with the ambulatory appendages of one side presented to the ocean and those of the other side firmly embedded in the sand. In this position they wait until an extra high wave washes over them and then return to the higher parts of the beach. Sometimes, after remaining in a place for considerable period without being wetted by a wave, the crab will change its position to one closer to the water".

"A large adult was put in an aquarium filled with sea-water and kept there for 6 hours. It was apparently in good condition when liberated at the end of this time. Another specimen left in the aquarium for 24 hours was also active when released. Other specimens placed in fresh (sic!) water lived only 5 hours and made frantic attempts to escape."

Ich selbst wiederholte diesen Versuch mit *Ocypode ceratophthalma*, mit der wahrscheinlich auch HARMS (siehe Fussnote S.238) arbeitete. Ich brachte 5 Exemplare, von denen eins jung, die übrigen alt waren, in gut durchlüftetes Wasser. Nach der zweiten Nacht war eins der grossen Tiere tot, halb aufgeessen; es ist sehr wahrscheinlich dass es den fortwährenden Angriffen seiner Genossen unterlag. Die übrigen 4 Tiere waren nach 70 Stunden, als ich den Versuch abbrach, noch ganz gesund. — Bei einem zweiten Versuch lebte ein Exemplar von *ceratophthalma* in gut durchlüftetem Wasser von 7 III, 2 Uhr n.m., bis wenigstens 10 III, 1 Uhr n.m., kletterte dann aber — wahrscheinlich während der Nacht — aus dem Aquarium heraus, nachdem es mehr als 70 Stunden unter Wasser gelebt hatte.

Was nun das Feuchthalten der Kiemenkammer anbetrifft, so brauchen wir nicht daran zu zweifeln dass die Lage der Müllerschen Öffnungen ihren Besitzern, *Uca* und *Ocypode*, von grossem Vorteil sein kann. Die Bemerkung ORTMANN'S in BRONN (p. 1183), dass man in den die Öffnungen umschliessenden Haarbüscheln nicht eine zum Einlassen der Luft in die Kiemenhöhle dienende Vorrichtung erblicken darf, dass aber vermittelt derselben die Bodenfeuchtigkeit des Aufenthaltsortes wie mit einem Schwamme aufgesogen und den Kiemen zugeführt wird, gibt zwar eine unrichtige Vorstellung des Geschehens (die Haare sitzen nur ganz aussen und führen kein Wasser in die Kiemenhöhle ein; die Öffnungen nehmen gerade sehr viel Luft auf), sie weist aber eventuell auf die günstige Lage der Öffnungen hin. Sobald die Tiere die 4. Beine ein wenig heben (eine geringe Hebung genügt), ruhen die Haarbüschel ganz oder fast ganz auf dem Boden und stehen die Öffnungen offen; es wird also Luft angesogen und diese Luft wird vielleicht feucht sein, da sie so dicht über dem immer feuchten Boden hängt <sup>2)</sup>).

Es würde bei den am meisten dem Landleben angepassten *Ocypoden* also in zweierlei Weise dafür gesorgt werden dass die Kiemenhöhle nicht austrocknet:

<sup>2)</sup> Es mag auch sein, dass die Tiere, mittels der von COWLES (siehe oben) beschriebenen Benetzungsweise, durch die Müllerschen Öffnungen Wasser aufnehmen.



1. die Einatmungsöffnungen liegen neben dem Boden, 2. die Tiere suchen oft das Wasser auf.

Wissen wir nun, dass für das Feuchthalten der Kiemenkammer gesorgt wird, so bleibt nur die Atmung selbst zu besprechen übrig. Offenbar wird nun bei den Krustazeeen in zwei Weisen eine Luftatmung erleichtert. Die eine Methode ist: die Kiemenkammerwand ist vaskularisiert, enthält Gefässe; die zweite ist: die Kiemenblättchen sind so fest dass eine Erstickung der Tiere durch Verkleben der Blättchen unter sich nicht stattfindet. Letztere Methode ist nicht kürzer bekannt als erstere, nur weniger; gelegentliche Bemerkungen über die Bedeutung fester Kiemenblättchen finden sich an mehreren Stellen; die Festigkeit der Kiemen geht dabei wohl meistens mit geringer Kiemenzahl parallel.

Was nun die Vaskularisierung der Kiemenhöhle von *Uca* anbelangt, so hat JOBERT, wie schon gesagt, die diesbezüglichen Verhältnisse für *Ucides* beschrieben. Hauptsache für uns ist vorläufig nur seine Schlussbemerkung: „l'appareil branchial des Crustacés ordinaires peut donc jouer ici le rôle d'un véritable poumon, et le sang peut retourner au coeur sans passer par les branchies: aussi je proposerai de donner aux Crustacés qui présentent cette disposition le nom de *Branchio-pulmonés*“ <sup>1)</sup>. Obgleich er nun angibt, dass sich gleiche Verhältnisse wie bei *Ucides* bei *Uca* und anderen Krabben finden, möchte ich dieser Mitteilung mit einiger Vorsicht begegnen, da die Gecarciniden und Ocypoden, wie auch schon aus den obigen Angaben hervorgeht, prinzipielle Unterschiede zeigen. Besieht man die Kiemenkammer von *Uca*, so gibt es in genau derselben Weise wie bei *Ocypode* (siehe unten) eine Scheidung in eine untere Kiemen- und eine obere Lungenkammer. Die Wand der letzteren ist mit einer (nach JOBERT gefässreichen) schwarz pigmentierten Hypodermis bekleidet. Ich hoffe noch Gelegenheit zu finden die JOBERTSchen Angaben über Gefässreichtum zu bestätigen. Die Zahl der Kiemen beträgt für *Uca consobrinus* auf jeder Seite 4; diese sind gut entwickelt.

Betreffs der Festigkeit der Kiemenblättchen von *Uca* kenne ich nur eine einzige Mitteilung, und zwar die folgende, von HARMS (p. 296). „Von den amphibisch lebenden *Uca*-Arten an bis zu den Ocypoden und *Gecarcinus* geht eine allmähliche Reduktion der Kiemen vor sich. Dabei wird die Cuticula der Kiemenäste immer dicker“. HARMS scheint hierüber selbst Beobachtungen angestellt zu haben; *Uca consobrinus* hat aber 4, *Ocypode* 6 - 7 Kiemen.

<sup>1)</sup> ORTMANN (p. 1038) bemerkt über die fremden Angaben JOBERTS folgendes: „Auf der das gewölbte Dach wie die Seitenwand der Atemhöhle auskleidenden weichen, schwärzlich grauen Membran, mit welcher offenbar die Hypodermis gemeint ist, breiten sich von vorn und von hinten her, mit ihren Verzweigungen einander zugewandt, grosse durch farbige Injektionen nachweisbare Gefässe aus, welche einerseits mit einem grossen Blutsinus, anderseits mit dem Pericardium communiciren sollen, deren näheres Verhalten aus den unklaren Angaben JOBERTS aber nicht zu ersehen ist. Denkbar wäre es, dass gewisse, die weiche Integumentlage mit Blut versehende Gefässe in diesem Falle behufs Herstellung eines Lungen-Gefässnetzes nach Art desjenigen der Landschnecken (*Pulmonata*) eine exceptionelle Entwicklung eingegangen seien, während andererseits die von JOBERT aufgestellte Behauptung, dass ein Blutlauf innerhalb der Kiemen von *Uca* überhaupt nicht stattfindet, schwerlich dem Sachverhalte entsprechen dürfte.“



Was *Ocypode*, die nächste Verwandte von *Uca*, anbelangt, so war schon MILNE-EDWARDS bekannt, dass die Wand der Kiemenkammer, die einen grossen leeren Raum über den Kiemen bildet, schwammig ist. Spätere Angaben liegen, so scheint es, nur vor von HARMS und PEARSE. HARMS (p. 296) bemerkt über *Ocypode ceratophthalma* nur, dass die Kiemenkammerwand Zotten zeigt, so dass die Wand schwammig erscheint und dass die dorsale Luftkammer von der ventralen kleinen Kiemenkammer durch ein Septum abgetrennt ist. Er gibt zwei Abbildungen, die die dorsale Wand und das Septum zwischen Kiemen- und Lungenhöhle zeigen. PEARSE (1929) sagt über *Ocypode albicans*: „The gills are reduced in number (12) and on each side two of them are fused into a great gill which is provided with two pairs of longitudinal vessels“. Ich kann hinzufügen dass auch *Ocypode ceratophthalma* eine solche doppelte Kieme besitzt, während *Ocypode arcuata*, nach der Abbildung in BRONN, Taf. 105, sie nicht zeigt. Weiter sagt PEARSE: „There are also five irregular rows of respiratory tufts along the blood-vessels on the membranous lining of the branchial cavity. These remind one of those described in *Birgus* by SEMPER“ (1878). Mit diesen rows of tufts sind die Hautfalten der Wand gemeint, wie aus einer Vergleichung seiner Abbildung mit der Dorsalwand der Kiemenkammer von meinen Exemplaren hervorgeht. Besieht man sich letztere an einem grossen Exemplar von *ceratophthalma*, so fällt einem die Übereinstimmung mit der Lungenhöhlenwand von *Helix pomatia* auf. — Die Festigkeit der Kiemenblättchen kam auch für *Ocypode* schon in der Bemerkung von HARMS zur Sprache. Er sagt, sie sind besser chitiniert als bei *Uca*, weniger als bei den Gecarciniden.

Was die geringe Zahl der Kiemen anbelangt, die wir auch bei mehreren Paguriden finden, GARDINER und PEARSE (PEARSE, 1929, p. 212) haben gezeigt, dass sie bei *Coenobita* sogar fortgenommen werden können, ohne dass die Tiere sterben. Wahrscheinlich sind denn auch einige Gecarciniden und die Coenobitiden unter den Pagurineen die am besten dem Landleben angepassten Krabben. HARMS (p. 297) hielt *Coenobita rugosa* und *cavipes* einen Monat und länger in einer Kiste mit Sand und Kies bei nur mässiger Feuchtigkeit; die Tiere waren dabei sehr munter <sup>1)</sup>. „Ich halte sie jetzt 1½ Jahr in Gefangenschaft. Auch hier beobachte ich so gut wie nie, dass die Tiere ins Wasser gehen, obwohl sie stets dazu Gelegenheit haben“. Bei diesen Formen bildet die Hautatmung am Abdomen eine wichtige Rolle.

Fragen wir jetzt, am Ende dieses Kapitels, also: wie ist es möglich, dass die Ocypoden (einschliesslich der Winkerkrabben), Tiere die Kiemen zu ihrer Atmung besitzen, die heisse Tropensonne in der furchtbaren Mangrove oder auf

<sup>1)</sup> Unter Wasser würden die Tiere nur ½ - 1 Tagen am Leben bleiben [HARMS, p. 298 und 307 - 308, nach HARMS gibt BORRADAILE (1903) gleiches an]. Ob bei diesen Versuchen auf den Sauerstoffgehalt des Wassers geachtet wurde, wird nicht angegeben: vgl. das über *Ocypode* gesagte. Ein Sterben unter Wasser ist, wenn man die Beobachtungen von HARMS in bezug nimmt, für *Coenobita rugosa* oder *C. cavipes* gewiss eher möglich als für *Ocypode*. Nur scheint mir: wenn ein Tier einen Tag unter Wasser aushält, so kann es das auch länger und ist von Erstickung vielleicht nicht die Rede, eher von ungenügender Sauerstoffzufuhr. Aber ich kann das nicht beurteilen, da die Experimente nicht beschrieben werden.



dem glühenden Korallensande ertragen, die doch von allen echten Lungenatmern gemieden wird? Denn das ist der Punkt, der jedesmal die Forscher der Tropen mit Erstaunen erfüllt hat. Da können wir erstens antworten, dass die Tiere sich stets feucht erhalten, zweitens dass die Wand der Kiemenkammer, besonders vorn-oben, als Lunge fungiert und drittens dass die Kiemen nicht leicht verkleben können durch ihre Festigkeit <sup>1)</sup>.

## 2. VERGLEICHUNG DER ATMUNG VON SESARMA TAENIOLATA UND MEINERTI MIT DER VON BATAVIANA UND CUMOLPE.

Die zweite Frage, die am Ende dieses Kapitels Beantwortung fordert, lautet ungefähr so: Lässt sich aus der Organisation <sup>2)</sup> der betreffenden Tiere begreifen, weshalb sehr nahe verwandte Arten, wie *Sesarma taeniolata* und *meinerti* einer gegenüber *S. bataviana* und *cumolpe* andererseits, in der Atmung so grosse Unterschiede zeigen, dass erstere Arten Lungen-, letztere Kiemenatmer scheinen?

Um diese Frage zu lösen, nahm ich die folgenden Experimente. In gut durchlüftetes Meerwasser brachte ich 17 *Sesarma taeniolata*, 8 *Sesarma cumolpe* und 10 *Sesarma bataviana*. Ich hatte also 17 Exemplare der „wasserfliehenden“ Art, 18 Exemplare „wasserliebender“ Arten. Meine Erwartung, dass *taeniolata* ertrinken würde, wurde ganz und gar nicht bestätigt, im Gegenteil! Es war ganz interessant, zu sehen, wie die Exemplare von *taeniolata* fortwährend versuchten aus dem Wasser herauszukommen, was während der Nacht denn auch 5 Exemplaren, offenbar durch Schwimmen, gelang. Aber nichtsdestoweniger ertrugen diese 5 Stück einen Unterwasseraufenthalt von mindestens 9, die übrigen 12 einen Verbleib unter Wasser von 24 Stunden. Nach dieser Zeit waren alle Tiere noch stets ganz aktiv und vollkommen normal. Hinzugefügt sei, dass sie teils jung, teils erwachsen waren. Die 7 *S. cumolpe* und 11 *S. bataviana* waren nach 24 Stunden — wie zu erwarten — ebenso ganz normal. Um zu sehen wie lange überhaupt *taeniolata* einen Unterwasseraufenthalt ertragen kann, brachte ich 3 Stück in gut durchlüftetes Meerwasser; eins der Tiere verblieb darin 120, die zwei anderen beließ ich darin 190 Stunden. Da sie auch nach dieser Zeit ganz normal waren darf man wohl behaupten dass *taeniolata* funktionell eine richtige Kiemenatmerin ist.

Ich setzte 12 *Sesarma taeniolata*, 8 *S. cumolpe* und 10 *S. bataviana*, nachdem sie zu den oben genannten Versuchen gedient und also alle die Kiemenkammer mit Wasser gefüllt hatten, in trockene offene Gefässe, um zu sehen, wie lange die Tiere die Austrocknung aushielten. Das Resultat findet man in folgender Tabelle und ausserdem wurde eins der während der Nacht 31/1 November geflüchteten Tiere am 4. November um 11 Uhr vormittags lebend in einem unserer Laboratoriumräume zurückgefunden, wo das Tier von nachts 31/1 bis zum 4. Nov. ohne Wasser gelebt haben muss.

<sup>1)</sup> Ich weise nochmals auf die beachtenswerte Mitteilung von HYMAN für *U. pugilator* hin. Vgl. Fussnote 2, Seite 237.

<sup>2)</sup> „Organisation“ als morphophysiologischer Begriff gemeint.



8.30 - 8.50 ein- gebracht	<i>taeniolata</i> 12 Stück	<i>cumolpe</i> 8 Stück	<i>bataviana</i> 10 Stück
1 Nov. 9 v.m.	—	—	—
10	—	—	♂ (12 mm)
11	—	—	—
12	—	—	—
1 n.m.	—	—	♂ (13)
2	—	♀ (7.5)	♂ (14.5), ♂ (13)
3	—	♂ (9.-)	♂ (15)
4	—	—	♀ ova (12), ♀ ova (11)
5	—	♂ (11.-)	♂ (12.5)
6	—	—	♂ (12)
7	—	♀ (14)	—
8	♂ (13) <sup>1)</sup>	♂ (13), ♀ (15.5)	—
9	—	—	♂ (13)
10	—	—	—
11	♂ (15)	♀ ova (16), ♀ (15)	—
12	—	—	—
2 Nov. 1-4 v.m. nicht nachgesehen	—	—	—
5	♂ (19), ♂ meinerti (43)	—	—
7.30	—	—	—
10	♂ (27)	—	—
11-1 n.m.	—	—	—
3-4	—	—	—
8	♀ ova (35), ♀ ova (37)	—	—
2/3 Nov. 12 nachts	♂ (29.5), ♀ ova (34), ♂ (40.5)	—	—
3 Nov. 6 v.m.	♂ (38.5), ♂ (37)	—	—

PEARSE (1929, p. 209) hat angegeben, dass kleine Exemplare von *Ocypode albicans* kürzer an der Luft leben als alte Tiere. "Apparently the size of a crab has a more or less direct relation to the length of the time it can conserve moisture and live in air" ..... Die Möglichkeit besteht also dass alte *taeniolata* nur ihrer Grösse wegen soviel länger an der Luft aushalten als alte *cumolpe* oder *bataviana*. Deshalb arbeitete ich nicht nur mit alten, sondern auch mit jungen *taeniolata*, von der gleichen Grösse als alte *bataviana-cumolpe*. Diese jungen *taeniolata* leben ebenso hoch wie die alten, soweit ich feststellen konnte nur dichter am Wasser, oberhalb der Zone von *bataviana-cumolpe*.

Aus den Beobachtungen geht hervor, dass die jungen *cumolpe* und *taeniolata* (die *bataviana*-exemplare zeigten zu geringe Grössenunterschiede) eher sterben als die erwachsenen Tiere der gleichen Art, wie von PEARSE auch für *Ocypode*

<sup>1)</sup> Die Zahlen geben die grösste Carapaxbreite in Millimetern an.



*albicans* angegeben wurde. Weiter zeigen die Wahrnehmungen, dass junge *taeniolata* offenbar nicht später sterben als Exemplare von *bataviana* und *cumulpe* von der gleichen Grösse. Im Gegenteil, die Tabelle zeigt deutlich, dass die Widerstandsfähigkeit der Tiere, der Austrocknung gegenüber, ziemlich gut ihrer Grösse entspricht und dass alte *taeniolata* hauptsächlich ihrer Grösse wegen so lange an der Luft aushalten. Erwachsene Exemplare von *Sesarma taeniolata* atmeten noch Wasser aus um 5.30 n.m. am 1. Versuchstag, 9 Stunden nachdem sie aus dem Wasser herausgenommen waren! Wie viel länger sie das maximal tun können weiss ich nicht.

Ich habe die Versuche darauf mit einer grösseren Zahl junger *taeniolata* wiederholt.

16 Nov., 11.30 v.m.	<i>taeniolata</i> 26 Stück	<i>bataviana</i> 27 Stück
12 Uhr	—	—
1	—	—
2	—	—
3	—	—
4	♂ (8.5)	—
5	♂ (7), ♂ (8.5), ♂ (10.5)	—
6	—	—
7	♂ (8.5), ♂ (9)	♂ (7.5), ♂ (8.5), ♂ (8.5), ♂ (9), ♀ (8.5), ♀ (11)
8	—	—
9	♂ (6.5), ♂ (7), ♂ (9.5), ♂ (9.5)	♂ (9), ♂ (11), ♀ <sup>1)</sup> (10), ♀ <sup>1)</sup> (11), ♀ <sup>1)</sup> (11.5)
10	—	♂ (10.5), ♀ (10), ♀ <sup>1)</sup> (10)
11	♂ (10.5), ♂ (11.5)	♀ <sup>1)</sup> (11), ♀ <sup>1)</sup> (11), ♀ <sup>1)</sup> (11), ♀ <sup>1)</sup> (12), ♀ <sup>1)</sup> (12.5)
12	♂ (12), ♂ (13.5)	♂ (13), ♂ (15), ♀ <sup>1)</sup> (14.5), ♀ <sup>1)</sup> (15)
1	♂ (14), ♂ (17.5)	♀ <sup>1)</sup> (11.5)
2	♂ (16), ♂ (16.5), ♂ (17)	♀ <sup>1)</sup> (12.5), ♀ <sup>1)</sup> (13.5)
3	♂ (14), ♂ (14.5), ♂ (15)	—
4	—	—
5	—	—
6	♂ (17.5)	—
7	—	♀ <sup>1)</sup> (11.5)
12	♂ (27), ♀ (27) und ♀ (30) noch lebend.	—

Aus dieser Tabelle geht deutlich hervor, dass junge *taeniolata* nichts länger dem Austrocknen widerstehen als Exemplare von *bataviana* von der gleichen Grösse.

Es wird jetzt also von Interesse, zu wissen, ob junge *taeniolata*, wie die alten, bei Flut auf die Bäume klettern, oder ob sie, wie *Sesarma bataviana* und

<sup>1)</sup> Weibchen mit Eiern.



*cumulpe*, unter die Oberfläche tauchen. Deshalb seien Beobachtungen, die ich bei sehr hohem Wasserstand am 16. und 17. November 1929 anstellte, hier kurz wiedergegeben. Beim Beginn des Hochwassers erschienen allererst alte *taeniolata* in ziemlich grosser Zahl an der Oberfläche. Ihre Zahl nahm je länger je mehr zu <sup>1)</sup> und nachdem das Wasser noch einige Stunden gestiegen und fast das ganze Gebiet der *taeniolata*-höhlen überströmt worden war, wurden sie auch von kleineren *taeniolata*, bis zu einer Grösse von vielleicht 25 mm (grösste Carapaxbreite) herab, vermehrt. Es war deutlich, dass diese jüngeren Tiere im Mittel später als die alten erschienen und auch fiel mir auf, dass die grossen Exemplare von etwas trocknerem Boden stammten als die kleineren. Das Erscheinen junger Exemplare von *taeniolata*, von der Grösse erwachsener *bataviana*, konnte ich nicht mit Sicherheit feststellen, auch nicht auf einem Teil, der von vielen bewohnt wurde. Es mag sein, dass ein längeres Überströmen auch diese Tiere zum Vorschein gebracht hätte, aus den Wahrnehmungen geht aber jedenfalls hervor, dass junge *taeniolata*, obgleich sie höher als *bataviana* wohnen, sich benehmen wie alte *bataviana*, nicht wie alte *taeniolata*.

Durch die Beobachtungen dieses Tags bedürfen aber auch die Angaben über das Benehmen von *Sesarma cumulpe* einer Berichtigung. Nach einigen Stunden der Überströmung nämlich, sass auch von dieser Art eine nicht geringe Zahl auf den Bäumen, Pneumatophoren, u.s.w. Obgleich an einer bestimmten Stelle, wo ich die Art am vorigen Tag zahlreich fand, keine Tiere heraufkamen, und sich also viele Tiere unter dem Wasser befanden, waren an anderen Stellen mehrere Tiere dem Wasser entflohen. Diese Tiere verschwanden bei Beunruhigung eher unter Wasser und blieben länger fort als *taeniolata*. Aus der Tabelle auf Seite 243 geht vielleicht hervor, dass *cumulpe* im Mittel eine etwas längere Austrocknung verträgt als *bataviana*. Die Beobachtungen draussen und im Laboratorium stimmen also in dieser Hinsicht überein.

Schliesslich habe ich die Kiemenkammer von *taeniolata* und die von *bataviana* untersucht. Dabei ergab sich, dass die beiden Arten, soweit feststellbar, keinen einzigen Unterschied im Bau der Kiemenkammer oder der Kiemen zeigen. Beide Arten haben die gleiche

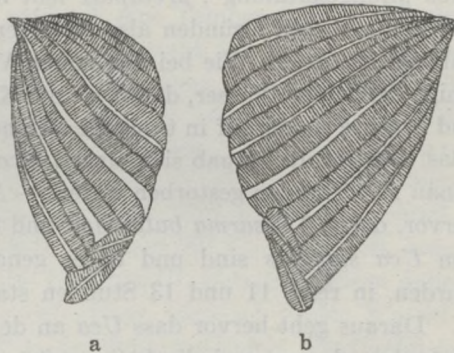


Fig. 20. Kiemen von a *Sesarma taeniolata*, b *S. bataviana*. Vergr. a  $\times 2$ , b  $\times 8$ .

<sup>1)</sup> Ich kann nicht unterlassen, nochmals darauf hinzuweisen, dass die alten *taeniolata* draussen bei einer solchen Überflutung durchaus den Eindruck erwecken: sie können nicht unter Wasser leben; obgleich wir jetzt wissen dass das unrichtig ist. Sie sitzen in ganz grosser Zahl über der Wasseroberfläche und lassen einen bis auf einige Meter herankommen. Man könnte annehmen, dass der O<sub>2</sub>-bedarf unter dem Wasser ungenügend gedeckt wird; das schnellströmende Wasser macht eine solche Annahme aber gewiss unmöglich; ausserdem versuchen sie auch in gut durchlüftetem Wasser die Oberfläche zu erreichen. Einem rezenten Beitrag von ISHIHAMA entnehme ich aber, dass hoher osmotischer Druck auf das „Kaltblüterherz“ (offenbar wurde nur mit *Rana* gearbeitet) hemmend wirken kann. Es ist vielleicht möglich dass die Höhe des osmotischen Druckes bei diesen Brackwasserkrabben eine Rolle spielen und das Wasserflüchten verursachen kann.



Kiemenzahl und genau die gleiche Lage der Kiemen (Fig. 20), beide haben einen sehr kleinen Sammelraum (BORRADAILES), und normale Kiemenkammerwände ohne eine Scheidung in eine Lungen- und Kiemenhöhle.

Zusammenfassend ergibt sich die merkwürdige Tatsache, dass sowohl die wasserliebende *Sesarma bataviana* als die wasserfliehende *Sesarma taeniolata* eine echte Kiemenatmung zeigen und unter Wasser ausgezeichnet leben können (diese Arten fressen auch unter Wasser). Dass dennoch erwachsene Exemplare von *Sesarma taeniolata* (junge nicht) einen starken Instinkt, dem Wasser zu entfliehen, besitzen, ist um so interessanter als dieser Instinkt offenbar nur beruht auf einem längeren Aushaltungsvermögen von grossen *taeniolata* einer Austrocknung gegenüber, soweit feststellbar nicht auf einem Organisationsunterschied.<sup>1)</sup>

### 3. VERGLEICHUNG EINER PUMPENDEN UND EINER NICHT-PUMPENDEN KRABBenART.

Bei einem ersten Versuch hielt ich 3 *Uca consobrinus* und 3 *Sesarma taeniolata* an der Luft und fand dass die *Uca* in weniger als 6 Stunden starben, die *taeniolata* 7 Stunden gut vertrugen (ich brach den Versuch dann ab). Der Versuch ermöglicht keine Vergleichung, da *Sesarma taeniolata* soviel grösser als *Uca* ist. Bei einem zweiten Versuch starben von 3 *Uca consobrinus* 2 Stück in 5 Stunden. Bei einem dritten Versuch verglich ich *Uca* und zwar *signatus*, als nicht-pumpende Art, mit der pumpenden *Metaplex elegans*. *Uca* lebt hoch und besitzt auch „Lungenatmung“, *Metaplex* lebt niedrig und besitzt Kiemenatmung; man würde aus diesen Gründen also erwarten dass *Uca* viel länger an der Luft aushält als *Metaplex*. Wie bei den ersten Versuchen hielt ich die Versuchstiere erst einige Zeit unter Wasser, damit sie die Kiemenkammer mit Wasser gefüllt hatten und brachte sie darauf in trockene, offene Glasgefässe, höchstens 2 Stück in jedes Glas. Als Resultat ergab sich, dass 7 *Uca signatus* in 10.5, 12 *Metaplex* ebenso in genau 10.5 Stunden gestorben waren. — Aus der Tabelle auf Seite 243 geht weiter hervor, dass 10 *Sesarma bataviana* und 8 *S. cumolpe*, die ebenso von der Grösse von *Uca signatus* sind und unter genau den gleichen Verhältnissen gehalten wurden, in resp. 11 und 13 Stunden starben.

Daraus geht hervor dass *Uca* an der Luft ebenso lange oder kürzer lebt als *Metaplex elegans* und die kleinen *Sesarma*-arten, obgleich *Uca* Lungenatmung besitzt und die anderen Arten eine niedrigere, also feuchtere Zone bewohnen als *Uca signatus*. Wir müssen hieraus schliessen, dass das Pumpen für amphibische Arten einen wesentlichen Vorteil bedeutet, so weit wir hier von Vorteil reden dürfen. Denn wir dürfen doch annehmen, dass ein Tier, das ausser Kiemen- auch Lungenatmung besitzt, in casu *Uca*, eine weniger feuchte Kiemenkammer zu seiner Atmung braucht als ein Tier mit blosser Kiemenatmung, in casu *Metaplex* oder *Sesarma*. Dass nichtsdestoweniger die beiden letzten Arten ebensolange oder sogar länger leben als *Uca*, zeigt dass die Nichtpumper eher als die Pumper ausgetrocknet sind. Es scheint also beim blossen Hindurchführen von Luft

<sup>1)</sup> In dieser Beziehung ist weiter bemerkenswert, dass *cumolpe*, die grösser als *bataviana* wird, sich normal unter Wasser flüchtet, teils aber dem Wasser entflieht.



durch die Kiemenhöhle mehr Wasser verloren zu gehen als beim Auspumpen und Wiedereinsaugen. Einige erwachsene Exemplare von *Sesarma taeniolata* atmeten, wie schon gesagt, denn auch 9 Stunden, nachdem sie dem Wasser entnommen waren, noch Wasser aus.

Soweit ich sehe, gehe ich in diesen Schlussfolgerungen nicht fehl. Man glaube aber nicht, ich möchte behaupten, dass *Uca* seiner Umgebung schlechter angepasst sei als *Metaplex* der seinigen. Natürlich passt die Organisation auch hier in harmonischer Weise zu der ihr zugehörigen Umgebung, wie wir das stets aufs neue wieder feststellen, wenn wir eine Art besser kennen lernen.

## 5. DER EINFLUSS EINIGER REIZE.

Der Einfluss verschiedener Reize auf *Uca* habe ich nicht systematisch untersucht. Ihr Studium, wie wichtig es auch zum besseren Begriff der Lebensweise dieser Krabben wäre, würde ausführliche reizphysiologische Untersuchungen notwendig gemacht haben, die ich nicht beginnen wollte. Ich gebe hier also einige unwesentliche Befunde wieder, die den Einfluss der Temperatur und des Lichtes betreffen. Über den Einfluss taktiler, chemischer und Lautreize wird hier ganz geschwiegen.

### A. EINFLUSS DER TEMPERATUR.

MAYOR (1918) hat darauf hingewiesen, dass viele Meertiere der Tropen ganz dicht bei ihrer Maximaltemperatur leben, wodurch eine Temperatursteigung viel gefährlicher als eine -sinkung für sie ist. Es ist interessant aus diesem Gesichtswinkel *Uca* zu betrachten. Die Winkerkrabben lieben ganz hohe Temperaturen, denn sie sind erst aktiv wenn die Sonne die meisten anderen Tiere in den Schatten verschwinden lässt; sie müssen also noch höhere Temperaturen *vertragen* können. — Der schwarze Schlamm Boden ihres Wohngebietes absorbiert die Wärme natürlich in starkem Masse. Am 2. Februar 1928, um 12.30 nachmittags, mass ich in den Wasserpflützen auf dem Schlamm 36° C., im Boden, nahe der Oberfläche, 36°, etwas tiefer 33° - 34°. Die Krabben (*U. signatus*) waren dabei sehr aktiv. Am 7. August 1929, 2 - 3 Uhr nachmittags, mass ich in den Wasserpflützen auf dem Schlamm 35° 5, 36° 5, 39° 3; der Schlamm Boden, oberflächlich, mass 38° -, 39° 3, 39° 3, einige cm tief 38°. Eine Anzahl *Uca* lief umher; hier und da eine *Metaplex*, *Sesarma bataviana* und *Periophthalmus*, diese, wie *Hamina*, meistens im Schatten.

Aus anderen Beobachtungen, die ich hier nicht nennen will, geht hervor, dass eine Temperatur von 28° C. als zu niedrig, eine Temperatur von ungefähr 30° C. als genügend empfunden wird. Aus den oben gegebenen Wahrnehmungen sieht man weiter dass die Tiere aktiv sind bei ganz hoher Temperatur: 36° und mehr. Um die heisseste Tageszeit bekommt man aber bisweilen den Eindruck, dass die Tiere den Schatten aufsuchen, und wenn diese Beobachtung richtig ist, so mag eine Temperatur von 39° schon nicht ideal sein. Das stimmt auch mit den weiteren Beobachtungen überein.



Ich hielt in zwei offenen Glasgefäßen nebeneinander *Sesarma bataviana* und *Uca signatus* + *consobrinus*. Beiden gab ich auf dem Boden des Gefäßes eine gleiche Menge Wasser, damit sie nicht austrockneten.

Zeit	Temperatur		Resultat
	<i>Uca signatus</i> und <i>consobrinus</i> , 5 Stück	<i>Sesarma bataviana</i> , 5 Stück	
8.15	26° 3 C.	26° 3 C.	Alle lebend.
9.—	31° 2 „	31° 4 „	„ „
9.40	33° 7 „	33° 7 „	„ „
10.25	35° 5 „	35° 6 „	„ „
11.—	39° 7 „	39° 3 „	„ „
11.20	40° 6 „	40° — „	Bei 40° C. 4 <i>Sesarma</i> tot, 1 fast tot. Bei 40° 6 5 <i>Uca</i> lebendig.
11.50	41° 2 „		4 <i>Uca</i> lebend, 1 abweichend.
12.15	42° — „		1 tot, 3 steif, 1 fast normal. Die 4 letzteren lebten im Schatten alle auf.

Die kleine Tabelle zeigt, dass *Uca* eine Stunde lang lebte in einer Temperatur, höher als die, die für *Sesarma bataviana* tödlich war. Der Tod trat nicht durch Erstickung ein; soviel ich ersehen konnte, fand er statt durch Koagulation des Eiweisses. Auch in den Fällen, in welchen *Uca* sich bei hoher Temperatur in meinen Terrarien ins Wasser flüchtete, sah man ein solches Tier plötzlich erstarren, und das steife Tier war im gleichen Moment tot. Wie dem auch sei, die Wahrnehmungen zeigen, dass die optimalen Temperaturen dieser Krabben nur einige Grade von ihrer Todestemperatur entfernt liegen.

Stets wieder wundert man sich darüber, wie genau die Anpassung verschiedener Tiere an ihre so verschiedene Umgebung auch in ihrer Optimum- und Endtemperatur zum Ausdruck kommt. Einerseits zeigt eine Dämmerungsart, wie *Sesarma bataviana*, eine niedrigere Optimum- und Maximumtemperatur als *Uca signatus* oder *consobrinus*, die genau das gleiche Gebiet bewohnen, aber Tagtier sind. Andererseits ist auffallend wie eine bestimmte Art ihre Temperaturgrenzen ändert, wenn man sie aus dem gemässigten Klima ins tropische hinein verfolgt oder umgekehrt. Hiermit behaupte ich nichts neues, man kann aber beim Studium lebender Tiere solche Zusammenhänge kaum genügend im Auge behalten.

#### B. EINFLUSS DER LICHTREIZE.

Der Lichtsinn von *Uca* wurde von HOLMES untersucht. Seine Arbeit kann ich in Batavia nicht einsehen, ich entnehme dem Beitrag von PEARSE (1914a, p. 416) aber, dass er positive Phototropie feststellte. Die Verhältnisse unter denen



er arbeitete kenne ich aber nicht. KOEHLER hat in einem seiner wertvollen Sammelreferate darauf hingewiesen (1924, p. 583), dass die Angabe: ein Tier sei positiv phototaktisch, ohne weiteres, keinen Wert hat, da wir schon längst wissen, in wie starkem Masse das Auftreten und Verschwinden und der Sinn bestimmter Taxieen von ganz verschiedenartigen Faktoren beeinflusst werden. Die Zoaea-larven des 1. Stadiums sind, wie HYMAN für *U. pugilator* und ich für *signatus* feststellte, in diffusem Licht ausgesprochen positiv phototrop. Übrigens ist es nicht immer leicht dergleichen Phototaxisbefunde im Zusammenhang mit der Biologie einer Art richtig zu verwerten; sie sind meistens zu schematisch. — Wie schon besprochen kommt *Uca* unter normalen Umständen erst bei ziemlich hohem Stand der Sonne hervor. Aber ich untersuchte nicht welche Rolle hier der Temperatur, welche dem Lichte zukommt. Mit dem Verschwinden der Sonne verschwindet dann auch *Uca*. — Wie schon gesagt, kommt die Art in Perioden, wenn der niedrige Wasserstand während der Nacht eintritt, auch frühmorgens hervor. Vielleicht bezieht sich die Mitteilung von PEARSE (1912, p. 115), dass die Tiere oft aktiv sind in mondlichten Nächten, auf derartige Perioden. Die Angabe ist von Interesse, da diese Mondlichtmenge wahrscheinlich einen Minimumwert für die Art darstellt und deshalb näher bestimmt werden sollte. PEARSE gibt an, dass er die Tiere in dunklen Nächten nicht hervorkommen sah. — Neben dieser orientierenden hat das Licht eine photokinetische Wirkung, über die ich aber ebensowenig Untersuchungen angestellt habe.

Das Sehen von *Uca* ist hauptsächlich ein Bewegungs-, in geringem Masse ein Formsehen. Auch PEARSE (1914, p. 425) gibt für die von ihm studierten *Uca*-arten an, dass "most crabs retreat into their holes when a man approaches within 15 meters", während ein stillsitzender Mensch ruhig zwischen den Tieren sitzen mag. Genau das gleiche gilt für andere fernsehende Krabben, für einige geradezu in noch stärkerem Masse. Die grossen *Sesarma*-arten reagieren auf einen herannahenden Menschen schon in einer Entfernung von 30 Meter und wahrscheinlich mehr, *Ocypode* nach COWLES (1908, p. 17) in einer Entfernung von 45 meter (50 yards) oder mehr <sup>1)</sup>. — Daneben sehen die Tiere auch nichtbewegende Objekte, und wenn sie sich einem unbeweglichen Menschen gegenüber nicht scheu benehmen, so besagt das nur, dass das Objekt, gerade weil es nicht bewegt, nicht als gefährlich empfunden wird. COWLES beschreibt für *Ocypode arena-ria* wie diese Art auch nichtbewegende Sachen sieht <sup>2)</sup>. Weiter vermögen die *Uca*-männchen, bloss mittels des Gesichts, Weibchen von Männchen und von ihnen einigermassen ähnlichen *Sesarma*-exemplaren zu unterscheiden. Bisweilen sieht man nämlich Männchen — und hier beschreibe ich zu gleicher Zeit die Weise in der die Paare gebildet werden — die blitzschnell auf ein Weibchen zu und hinter ihm her rennen. Es kann so blitzschnell geschehen, dass das Weibchen kaum das sich nähernde Männchen bemerkt hat. Das Weibchen wird gegriffen und unter das Männchen gebracht. Gleiches beobachtete ich für *Sesarma bata-*

<sup>1)</sup> Juni 1930 stellte ich mehrmals 40 - 50 m fest als Maximumentfernung in der *Ocypode ceratophthalma* vor einem Menschen flüchtet.

<sup>2)</sup> Für das Sehen von *Ocypode* sehe man auch HARMS, p. 358 - 359.



*viana*. Hieraus braucht noch nicht hervorzugehen dass das Weibchen mittels des Gesichts erkannt und nicht gerochen wird. Letzteres würde an sich unwahrscheinlich, k ö n n t e aber möglich sein. Kommen nun aber Männchen vor, deren grosse Schere fehlt, so kann man bisweilen beobachten (ich sah es im ganzen vielleicht 3 - 4 Mal), wie ein derartiges Männchen in genau derselben Weise verfolgt und gegriffen wird. Auch jetzt bringt das normale Männchen es unter sich, um es aber gleich darauf wieder loszulassen. Aus dieser Beobachtung geht also hervor, dass das Formsehen der Tiere nicht so ganz schlecht sein kann, dass das Erkennen der Geschlechter an erster Stelle mittels des Gesichts stattfindet und dass dabei die Anwesenheit oder das Fehlen der grossen Schere den Durchschlag gibt. Es würde interessant sein, weiter festzustellen, wodurch kleine *Sesarma*-exemplare von *Uca*-weibchen unterschieden werden; vermutlich geschieht das an Unterschieden in der Fortbewegungsweise.

Ein weiterer Punkt, der grosses Interesse beansprucht, ist die Frage, ob die Tiere farbentüchtig sind. Farben spielen im Aussehen der Winkerkrabben eine wichtige Rolle. Besonders der Rücken und die grosse Schere sind stets hell, bisweilen ganz hell — dunkelrot, lichtblau, gelb bis orange — gefärbt, und fast jede Art zeigt dabei ganz typische konstante Färbungsunterschiede, deren Beschreibung leider meistens vernachlässigt wurde, so dass man sie nirgends angegeben findet. Und da gerade die grosse Schere eine so wichtige Rolle im Leben der Winkerkrabben spielt, so ist die Annahme, dass die Tiere vielleicht Farben unterscheiden können, gewiss berechtigt. Soviel ich weiss ist Farbentüchtigkeit unter den Krustazeeen bis jetzt festgestellt für *Daphnia* und einige Verwandte; wir dürfen also gewiss erwarten, dass sie unter anderen Formen, und bestimmt unter den Dekapoden, zu den Möglichkeiten gehört. Es liegt hier ein ausgedehntes Feld für weitere Untersuchungen.

## 6. DIE FORTPFLANZUNG UND ENTWICKLUNG.

Wie bekannt ist für einige tropische Meerestiere eine auffallende Fortpflanzungsperiodizität bekannt, die mit den Mondphasen zusammenhängt. Am bekanntesten ist der Fall des Palolo und einiger anderer Würmer. MUNRO FOX hat neuerdings aber gezeigt, dass auch für *Diadema saxatile* L. in der Nähe von Suez eine ähnliche Periodizität gilt und seinem Beitrag entnehme ich dass auch für die Chitonide *Chaetopleura apiculata* bei Woods Hole von CROZIER und GRAVE, und für den Fisch *Leuresthes tenuis* in Californien von W. F. und J. B. THOMPSON, eine gleiche Periodizität festgestellt wurde. Was nicht-tropische Meerestiere anbelangt, so glaubt ORTON (1926) eine mit den Mondphasen zusammenfallende Periodizität für *Ostrea* bei Falmouth festgestellt zu haben (siehe aber SPÄRCK 1926), während AMIRTHALINGHAM (1928) sie feststellte für *Pecten opercularis* bei Plymouth.

Ausser einer mit den Mondphasen zusammenfallenden kennen wir eine mit den Gezeiten zusammenfallende Periodizität (man sehe bei Fox, p. 535) und weiter findet Fox für einige Arten ein simultanes, obgleich nicht-perio-



disches spawning (*Strongylocentrotus lividus* bei Alexandrien, Neapel, Marseilles und Roscoff, *Mytilus variabilis* bei Suez), das offenbar nicht von Gezeiten oder Mondphasen abhängig ist. Bedenkt man weiter dass eine Periodizität (wie die von *Diadema* in Suez) auf einige Monate des Jahres beschränkt sein kann, da im übrigen Teil des Jahres nicht fortgepflanzt wird, dann begreift man dass eine viel grössere Zahl von Beobachtungen nötig ist, bevor wir Einsicht in diese Sache besitzen. Aus den vorläufigen Mitteilungen der Englischen Great Barrier Reef Expedition wissen wir dass wir von ihrer Seite weitere wertvolle Funde erwarten dürfen. Für einige tropische Meeresfische scheint sich eine deutliche Fortpflanzungsperiodizität feststellen zu lassen, die hier meistens eine jährliche oder halbjährliche zu sein scheint. Auch für viele tropische Vögel ist eine solche fast ebenso deutlich ausgesprochen wie in gemässigten Zonen.

Unter den kleineren Krabben kann man eiertragende Weibchen (z.B. von *Sesarma bataviana* und *Uca signatus*) bei Batavia offenbar zu jeder Zeit des Jahres antreffen. Zwar hat SLUITER das für die Evertrebraten aus der Bai von Batavia im allgemeinen angegeben, diese Angabe ist aber unrichtig, denn mehrere Echinodermen und vermutlich auch Arten anderer Gruppen halten eine deutliche Periodizität inne. Für die kleinen Krabben ist das Fehlen einer solchen Periodizität um so merkwürdiger als sie unter einigen grossen Krabbenarten zu den besonders von den Gecarciniden bekannten Fortpflanzungswanderungen Anlass gibt. Besieht man aber die Tabelle auf Seite 244, so geht aus ihr hervor, dass unter 18 am 16. Nov. 1929 (Springflut) gefangenen Weibchen von *Sesarma bataviana* 15 Stück Eier trugen. Und auch aus anderen Notizen geht hervor, dass — obgleich man zu jeder Zeit eiertragende Weibchen finden kann — zu bestimmten Zeiten sehr viele Weibchen Eier tragen. Wir würden also hier mit Hauptfortpflanzungsperioden zu schaffen haben, von denen wir nicht wissen ob sie lunärem oder anderem Einfluss ihre Entstehung verdanken. Unter den von uns behandelten Krabben scheint die grosse *Sesarma taeniolata* am deutlichsten periodisch fortzupflanzen. Am 1. August 1929 und folgenden Tagen fing ich mehr als 25 ♀♀ dieser Art, von denen keines Eier trug; ich untersuchte die Ovarien von 10 Stück, die ganz unentwickelt waren. Am 31. Oktober 1929 fing ich 6 ♀♀, von denen 4 Eier trugen, am 17. November (Springflut) beobachtete ich viele Weibchen draussen; nicht weniger als 12 Stück unmittelbar um mich herum trugen Eier, und auch die weiteren Weibchen, die ich sah, hatten Eier unter dem Abdomen.

*Uca signatus* pflanzt sich bei Batavia also wahrscheinlich das ganze Jahr hindurch fort. Die kleinsten eiertragenden Weibchen, welche ich fand, hatten eine grösste Carapaxbreite von resp. 8.6 und 9 mm (wie ich unten besprechen werde, findet die äussere geschlechtliche Differenzierung viel früher statt). Die Eier werden, wie zu erwarten, unter dem Abdomen getragen, und zwar sind sie da, wie für die Krabben bekannt, mittelst Fäden zähen Schleimes befestigt. Ihre Zahl betrug in dem einen untersuchten Fall mehr als 18000; der Diameter ist ungefähr 250  $\mu$  (0.2 - 0.3 mm).

Die Entwicklung der Eier kann eine merkwürdig lange Zeit in Anspruch



nehmen. In Fällen, in denen Weibchen in meinen Terrarien zur Fortpflanzung schritten oder in denen ich eiertragende Weibchen isolierte, fand ich für die Entwicklungsdauer ungefähr: 8, 9, 16, 16, 23 Tage. Im letzten Fall starben die Jungen im Ei ohne auszubrechen. — Zweifellos geben diese Zahlen, jedenfalls die höheren Werte, eine unrichtige Vorstellung von der Entwicklungsdauer; sie zeigen nur dass die Verhältnisse in meinen Terrarien, obgleich die Tiere fortpflanzten, nicht ideal waren. Die Dauer mag normal ungefähr eine Woche betragen. — Für *Sesarma cumolpe* fand ich einmal eine Entwicklungsdauer von ungefähr 17, für *Paracleistostoma depressum* von ungefähr 13 Tagen. Auch diese Zeiten scheinen mir zu lang. — Die Jungen kriechen in dem Zoaeastadium aus. Sie haben die gewöhnliche Gestalt der Krabbenzoaea und zeigen ein gut entwickeltes, aber nicht langes Dorsal- und Rostralthorn. Das gleiche gilt für die Larven von *Sesarma bataviana* und *Sesarma cumolpe*. Die Larve von *Paracleistostoma depressum*, obgleich auch in dem Zoaeastadium auskriechend, weicht stark von diesen Larven ab. Das Dorsalthorn fehlt, weiter haben die Tiere eine merkwürdige Ausstülpung ventral am Telsonsegment, offenbar eine Art Anushügel, und weiter haben sie ein schwaches Rostralthorn und gerundeten Thorakalschild. Bei alten *Paracleistostoma* deckt das Abdomen ausserdem einen so tiefen Raum unter dem Thorax ab, dass die Eier ganz abgeschlossen liegen und unsichtbar sind; man muss da also erst diesen Deckel heben. Ähnliches gibt BALSS für die Ordnung der Oxystomata und die Oxyrhynchen-gattung *Collodes* an. — HYMAN, der uns eine ausführliche Beschreibung der Larvenstadien der Winkerkrabben gegeben hat, sagt dass die eiertragenden Weibchen nur nachts hervorkommen. Er untersuchte *U. pugilator*. PEARSE (1914 b, p. 795) sagt aber von *Uca pugnax*-weibchen: "They wandered boldly over the sand and could be picked out at once by the dark mass of eggs which caused the abdomen to hang down below the body." Und weiter: "No females of *Uca pugilator* were observed to be carrying eggs until the first part of August." Auch für die von mir beobachteten *Uca*-arten würde die Angabe von HYMAN unrichtig sein.

Die Jungen werden im Wasser abgesetzt, wozu die Krabben letzteres also aufsuchen. Im Prinzip haben sie daher die gleiche Brutsorge wie die echten Landkrabben. HYMAN sagt dass seine Tiere (Nord-Amerika) stets abends von 7-8 ihre Eier absetzten. Die Larven sind am Tage stark positiv phototrop, jedenfalls wenn man sie in diffusem Licht hält oder wenn die Sonne ihr Gefäss nur teilweise beleuchtet. Sie haben dies mit den Larven der anderen oben genannten Arten gemein. HYMAN gibt gleiches für das 1. Zoaea-stadium von *Uca pugilator* an. Wir wissen durch die schönen Arbeiten RUSSELLS endlich dass die meisten niederen Meerestiere höchstwahrscheinlich auf eine bestimmte Lichtstärke eingestellt sind und dass wahrscheinlich diese Einstellung die Tiefe- und Oberflächenwanderungen vieler Planktontiere grösstenteils verursacht. — Ich habe kaum den Mut mitzuteilen, dass meine Larven von *Uca*, *Sesarma* und *Paracleistostoma* alle nach höchstens drei Tagen eingingen. Sie befanden sich, wie zu erwarten, noch in dem Zoaeastadium, und ich kann also über Metazoea, Megalopa und die ersten Stadien der definitiven Krabbe nichts aussagen.



HYMAN (1922) hat ausführliche Beobachtungen über die larvalen Stadien von *Uca pugilator* und deren Dauer mitgeteilt. Er unterscheidet die folgenden Stadien.

Stadium	Grösse	Ungefähre Dauer (in Tagen)
1. Zoaëa	Länge 1 mm	4-5
2. "		7
3. "		7
4. " (1. Metazoaëa)	" 2 "	7
5. " (2. " )		7
Megalopa	" 3 "	Lebt schon am Boden. 3-4 Wochen, verbirgt sich dann noch einige Tage bis eine Woche.
1. junge Krabbe		3-4
2. " "	1.5 mm lang, 2 mm breit	4-5
3. " "	3 mm breit, äussere geschlechtliche Differenzierung.	7

Die ganze Dauer nimmt also, bis zum 4. Krabbenstadium, ungefähr 12 Wochen in Anspruch. Aus dem Beitrag geht hervor, dass der Platz ziemlich nördlich liegt, die Dauer würde in den Tropen viel kürzer sein.

HYMAN gibt an, dass die Krabben des 3. Stadiums sich schon Höhlen graben können von einigen cm tief. Weiter teilt er mit dass Tiere mit einer Carapaxbreite von 4 mm schon einen deutlichen Geschlechtsdimorphismus zeigen.

Tiere dieser Grösse fand ich, zusammen mit jungen *Sesarma*, Anfang November 1928 in ganz grosser Zahl an der Mündung eines kleinen Gewässers westlich von Batavia, ganz nah am Meer. Die kleinsten Weibchen, die ich fing, hatten eine grösste Schildbreite von 5.1 (1 ×) und 5.9 mm (1 ×), die kleinsten Männchen von 4.5 (1 ×), 5.— (2 ×), 5.1 (1 ×), 5.3 (2 ×), 5.4 (2 ×), 5.8 mm. Die Weibchen massen 5.1 - 9.—, die Männchen 4.5 - 6.7 mm. Man fragt sich unwillkürlich, ob es Zufall ist, dass die jungen Männchen kleiner als die Weibchen sind. Sie zeigten schon gut entwickelte sekundäre Geschlechtsmerkmale: das Abdomen ist beim Weibchen etwas breiter als beim Männchen, während das Männchen die beiden Scheren ungleich gross hat. — Auch diese Tierchen gruben sich schon Höhlen, deren Diameter natürlich ihrer Körpergrösse entsprach (Höhlen der *Uca*-jungen 3 - 4, der noch kleineren *Sesarma*-jungen ab 2 mm). Ich habe keine ausführlicheren Beobachtungen über sie angestellt, es würde interessant sein zu wissen ob die Männchen dieser geringen Grösse schon winken.



Die jungen Tiere sind oben mattschwarz. Ein Männchen von 6.7 und zwei Weibchen von 8.1 und 8.6 mm grösste Schildbreite zeigen eine beginnende weisse Punktierung. Die Männchen bleiben punktiert bis sie eine gewisse Grösse erreichen; frühestens wenn sie ungefähr 11.5 mm grösste Schildbreite haben (oft viel später, erst wenn diese Breite 14 mm beträgt) tritt eine blaue Fleckung auf, die allmählich die weisse Punktierung ersetzt, bis letztere verschwunden ist (frühestens bei 13.5 mm grösste Schildbreite, meist später). — Die Weibchen werden braunschwarz bis braun, mit deutlicher oder undeutlicher Punktierung; auch sie können eine blaue Zeichnung kriegen (auch hier mit zunehmender Grösse?).

Die grössten Männchen, welche ich mass, hatten 17.— (2 ×) und 18 mm grösste Schildbreite (52 Stück gemessen), die grössten Weibchen massen 15.2 und 15.7 mm (25 Stück gemessen). Man könnte also den Eindruck bekommen dass die Weibchen kleiner bleiben, obgleich sie anfangs vielleicht schneller als die Männchen wachsen.

Wir würden zuletzt noch auf die merkwürdige Tatsache der einseitigen Scherenentwicklung hinweisen können. Sowohl die linke wie die rechte Schere kann sich beim Männchen zur „grossen“ Schere entwickeln und zwar findet man stets ungefähr 50 % beider Fälle vertreten. MORGAN hat angenommen dass diese Verteilung daherrührt, dass kleine Scheren beim Verlust der grossen Schere zur grossen Schere werden (Scherenumkehrung), was nach der Wahrscheinlichkeitsrechnung in der Hälfte der Fälle die linke oder die rechte sein würde. „So wäre denn die Proterochirie der erwachsenen Tiere auf den Zufall zurückgeführt“ (BALSS). Diese Annahme scheint mir gewagt.

Wie schon gesagt zeigten die kleinsten eiertragenden Weibchen eine grösste Carapaxbreite von 8.6 und 9.— mm. Eine Kopulation der Tiere wurde nie von mir beobachtet. Wie bekannt findet die Befruchtung bei den Krabben innerlich statt, wobei eine einzige Kopulation für mehrere Eiablagen genügt. Die Eier werden dann nach einiger Zeit befruchtet abgesetzt. Auch andere scheinen in der Natur nie eine Kopulation der doch so zahlreichen Winkerkrabben beobachtet zu haben; es mag sein dass sie in den Höhlen stattfindet. Überhaupt beobachtet man kopulierende Krabben ganz selten, ich selbst kenne nur die Kopulation von *Neptunus pelagicus*, und zwar aus dem Aquarium. PEARSE (1914b, p. 799 - 800) hat in seinen Terrarien fünf Kopulationen von *Uca pugilator* beobachtet und bildet auch kopulierende Tiere ab. Er gibt an dass alle kopulierende Weibchen einen harten Carapax zeigten, woraus hervorgehen würde dass die Kopulation hier nicht der Mauser zu folgen braucht. Genauer über den ganzen Verlauf der Befruchtung und Eiablage und ihren Zusammenhang mit der Mauser bleibt noch zu untersuchen.

Für die Mitteilung über das gegenseitige Erkennen der Geschlechter sehe man im vorigen Kapitel, Seite 249 - 250.



## ZUSAMMENFASSUNG.

Der Beitrag beschäftigt sich mit der Oekologie und Biologie einiger Mangrovekrabben der Genera *Sesarma*, *Metaplax*, *Ilyoplax*, *Uca*, *Scylla*, u.a. Weiter teilt sie einige oberflächliche oekologische Beobachtungen über Mangrove-schnecken mit.

## ERSTER TEIL.

A. Es werden fünf oekologische Zonen unterschieden, die durch bestimmte Krabben und Schnecken charakterisiert werden und für die der Feuchtigkeitsgrad des Bodens, da er die Nahrungsverhältnisse der Tiere bedingt, ausschlaggebend ist. Diese Zonen lassen sich nicht nur bei Batavia, sondern auch anderswo in der Mangrove unterscheiden.

Die biologischen Eigentümlichkeiten der Mangrovetiere sind:

1. Widerstandsfähigkeit gegen Änderungen des Salzgehaltes;
2. viele Mangrovetiere sind Schlammfresser;
3. viele Mangrovetiere leben amphibisch, diese Wechselatmer lassen sich in zwei Gruppen einteilen, deren erste Tiere umfasst, die funktionell hauptsächlich Lungenatmer sind, während die Tiere der zweiten Gruppe funktionell hauptsächlich Kiemenatmer sind.

B. Die Zonen und die Biologie ihrer Bewohner werden besprochen. Zusammenfassend ergibt sich, dass alle Tiere, ausser *Thalassina anomala* und *Macrophthalmus definitus*, sich streng an ihre bestimmte Zone halten und dass alle Krabbenarten der Mangrove Höhlen graben, die das Grundwasser erreichen, das den Tieren zu ihrer Befeuchtung dient. *Thalassina* stört sich deshalb an keine Zonenbildung, da diese Art unter der Oberfläche ihre Nahrung sucht.

## ZWEITER TEIL.

Oekologische, biologische und physiologische Beobachtungen über *Uca signatus*, mit vergleichenden Betrachtungen über andere Krabbenarten.

1. Das Graben und Abschliessen der Höhlen und das Reinigen der Augen, Scheren, u.s.w. werden beschrieben.
2. Das merkwürdige Winken von *Uca* und einigen anderen Krabbenarten dient zur Andeutung der Gebietsgrenzen und ist nicht „Demonstration“ den Weibchen gegenüber. Das Winken scheint nur bei den Arten vorzukommen, die in grosser Zahl dicht beisammen wohnen, dabei an eine bestimmte Höhle gebunden sind und um den Höhleneingang herum den Boden fressen. Die Grösse des Wohngebiets und der Kampf werden besprochen.
3. Die Nahrung von *Uca* besteht aus der Oberflächenschicht des Schlammes, welche, ausser Sandkörnern, auch Pflanzenteile, Diatomeen, niedere Tiere, deren Eier und Larven, u.s.w. enthält. Es wird ausschliesslich Schlamm, nie gröbere Nahrung von *Uca* gegessen. Die Nahrungsaufnahme wird behandelt. Die Mundteile besorgen die Sichtung des Schlammes in brauchbares und



unbrauchbares Material, und zwar findet die Sichtung vorwiegend nach der Qualität, nicht nach der Grösse der Partikelchen statt. Das nicht brauchbare Material wird auf den Boden zurückgelegt. Die Mundteile werden abgebildet und verglichen mit denen von *Cancer* und *Carcinus*, die Bedeutung der Abweichungen der *Uca*-mundteile von denen dieser beiden Arten bleibt dunkel.

Der Schlamm wird nur unvollständig ausgenutzt, da auch das verweigte Material einen gewissen Teil organischer Reste enthält. Von dem aufgenommenen Material werden, ausser den Sandkörnern, auch die grösseren Stücke organischen Abfalls (besonders Pflanzenteile) nicht ausgenutzt. — Der Magensaft von *Uca* verzehrt Fibrin in alkalischem Milieu, verzehrt langsam Bindegewebe (Catgut) und enthält eine Lipase, Amylase und Invertase.

4. Besprechung der Mechanik der Krabbenatmung, nach Beobachtungen an *Scylla*, *Potamon*, u.a.; der Weg des Atemwassers in der Kiemenkammer, Ein- und Ausströmungsöffnungen, die Funktion der Epipodite und Exopodite. Man kann die Mangrovekrabben nach ihrer Atmung in zwei Gruppen einteilen. Die Tiere der ersten Gruppe pumpen, wenn sie aus dem Wasser genommen werden, das Wasser aus der Kiemenkammer heraus; das Wasser wird dann, nachdem es über die Körperoberfläche geströmt ist, wieder eingesogen. Die Tiere der zweiten Gruppe pumpen Luft durch das Wasser hindurch. Zur ersten Gruppe gehören unter den hier untersuchten Tieren *Sesarma*, *Ilyoplax*, *Metaplax*, *Macrophthalmus*, zur zweiten Gruppe *Grapsus*, *Uca*, *Ocypode* und *Potamon*.

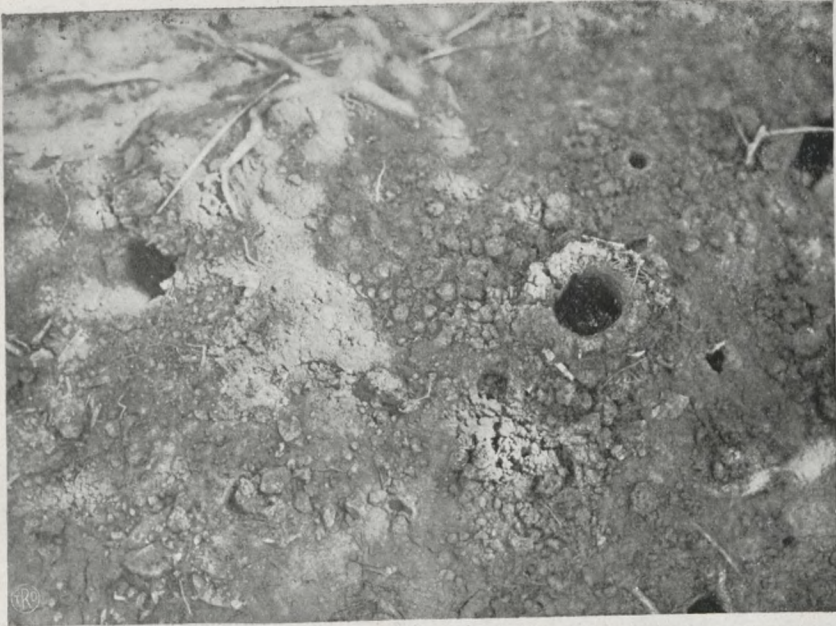
*Uca* und *Ocypode* besitzen — wie bekannt — grosse Öffnungen am Carapaxrand zwischen den Basen der 3. und 4. Beine; durch diese Öffnungen wird unter Wasser Wasser, an der Luft Luft eingesogen.

Dass *Ocypode* nur kurze Zeit unter Wasser leben kann ist unrichtig. — Wenn kein Wasser zur Benetzung da ist, ist *Uca* bald ausgetrocknet. Benetzung, eine teilweise (vorn-oben) als Lunge fungierende Kiemenkammer, und feste Kiemenblättchen, die nicht leicht verkleben, ermöglichen es den Ocypoden, die heisse Tropensonne zu ertragen.

*Sesarma taeniolata* klettert bei Flut auf die Bäume, *Sesarma bataviana* sucht bei Flut ihre Höhle auf. Die alten *Sesarma taeniolata* leben an der Luft viel länger als alte *bataviana*; junge *taeniolata*, von der Grösse von alten *bataviana*, sind indessen an der Luft ebenso schnell ausgetrocknet wie letztere. Nur ihrer Grösse wegen halten alte *taeniolata* so lange an der Luft aus. Beide Arten, *taeniolata* und *bataviana*, zeigen keinen Unterschied im Bau der Kiemenkammer oder der Kiemen. Unter Wasser kann *taeniolata* dem Wasser zu entfliehen, beruht nur auf einem längeren Aushaltungsvermögen dieser grossen Tiere einer Austrocknung gegenüber.

Die Vergleichung einer pumpenden und einer nichtpumpenden Krabbenart von gleicher Grösse zeigt dass eine nichtpumpende Art eher als eine pumpende ausgetrocknet ist. Es scheint also beim blossen Hindurchführen von Luft





H. BOSCHMA photo.

- Fig. 1. Trockener Boden der ersten Zone, mit zwei Höhlen von *Sesarma taeniolata* und Höhlen von *Uca*. Moeara Petjah (M. Tangerang), westlich von Batavia, 15. Januar 1930.
- Fig. 2. Zweite Zone: *Uca consobrinus* (♂♂ und ♀♀) und Luftwurzeln von *Sonneratia*. Moeara Petjah (Tangerang), Batavia, 15. Januar 1930.









H. BOSCHMA photo.

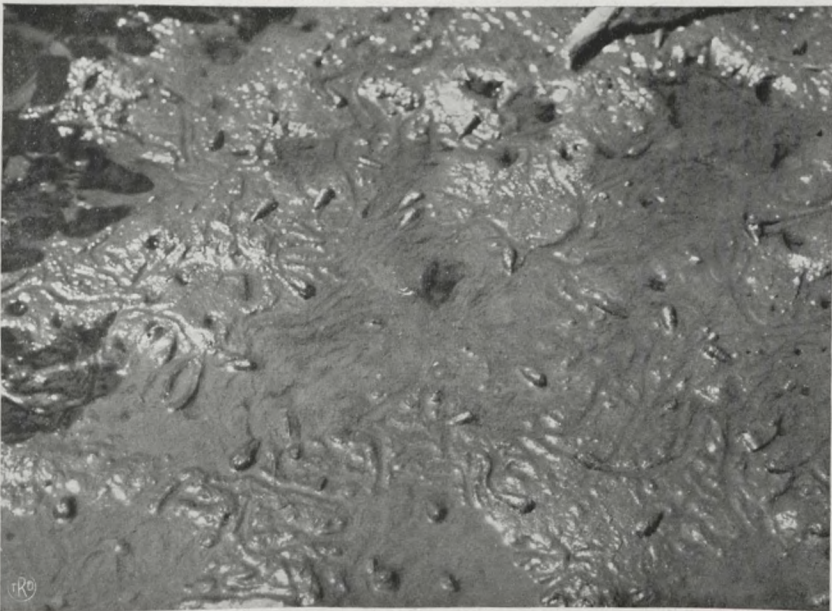
Fig. 3. *Uca signatus* mit deren Höhlen in der dritten Zone. Moeara Petjah (M. Tangerang), Batavia, 15. Januar 1930.

Fig. 4. 4 ♂♂ von *Uca signatus* und ein Gehäuse von *Cerithidea alata* in der dritten Zone. Moeara Petjah (M. Tangerang), Batavia, 15. Januar 1930.









H. BOSCHMA photo.

Fig. 5. 3 ♂♂ *Ilyoplax delsmanni* und ein ♂ *Uca signatus* in der dritten Zone. Moeara Petjah (M. Tangerang), Batavia, 15. Januar 1930.

Fig. 6. *Cerithidea alata* in der fünften Zone. Moeara Petjah (M. Tangerang), Batavia, 15. Januar 1930.









H. BOSCHMA photo.

- Fig. 7. Bruthöhle von *Periophthalmus* in der fünften Zone. Moeara Petjah (M. Tangerang), Batavia, 15. Januar 1930.
- Fig. 8. Burg von *Thalassina anomala* und Stelzwurzeln von *Rhizophora*. Moeara Petjah (M. Tangerang), Batavia, 15. Januar 1930.









J. H. F. UMBGROVE photo.

Fig. 9. Boden mit *Uca*-höhlen, ausgetrocknet während einer Periode niedrigen Wassers. Nördlich von Batavia, Januar 1928.









L. V. WIJNHAMER photo.

Fig. 10. Oberer Rand einer Schlammbank mit *Uca consobrinus*. Der Boden ist über und über bedeckt mit Klümpchen verweigten Schlammes. Moeara Petjah (M. Tangerang), Batavia, 17. April 1930.









L. V. WIJNHAMER photo.

Fig. 11. Rechts von der Mitte junger, steiler Schlammhügel von *Thalassina anomala* in teilweise entwaldetem Gebiet. Moeara Petjah (M. Tangerang), Batavia, 17. April 1930.









L. V. WIJNHAMER photo.

Fig. 12. Alter, mit der Farne *Acrostichum aureum* bewachsener Schlammhügel von *Thalassina anomala* in teilweise entwaldetem Gebiet. Moeara Petjah (M. Tangerang), Batavia, 17. April 1930.









J. H. F. UMBGROVE photo.



L. V. WIJNHAMER photo.

- Fig. 13. Von *Sesarma taeniolata* ganz umgepflügter Boden, mit Burgen von *Thalassina anomala*. Die Hügel sind alt und unten erodiert, später wieder aufgebaut worden. Mangrove nördlich von Batavia, dicht am Meer, Januar 1928.
- Fig. 14. Burgenkomplex von *Thalassina anomala* in teilweise entwaldetem Gebiet. Die höchsten Burgen sind ungefähr 1.4 m hoch. Mangrove-innengrenze, Moeara Petjah (M. Tangerang), Batavia, 17. April 1930.







durch die mit Wasser gefüllte Kiemenhöhle mehr Wasser verloren zu gehen als beim Auspumpen und Wiedereinsaugen.

5. MAYOR hat darauf hingewiesen, dass viele Tropicentiden sehr dicht bei der Temperatur leben, die sie maximal ertragen. Dies gilt auch für *Uca* (man sehe im Text).

*Uca* ist — wie bekannt — ausgesprochenes Tagtier. Es wurde nicht untersucht in wieweit Licht, in wieweit Temperatur hier von Einfluss sind. Das Sehen von *Uca* ist hauptsächlich ein Bewegungs-, in geringem Masse ein Formsehen; die Männchen von *Uca* erkennen die Weibchen offenbar am Fehlen des grossen Chelipeds.

6. *Uca* scheint das ganze Jahr hindurch fortzupflanzen. *Sesarma taeniolata* (weniger ausgesprochen vielleicht auch *S. bataviana*) scheint periodisch fortzupflanzen. Die Entwicklungsdauer der Eier kann sehr verschieden lang sein. Die Larven von *Paracleistostoma depressum* weichen morphologisch von denen von *Sesarma* und *Uca* ab: u.a. fehlt das Dorsalhorn. Einige Beobachtungen über Wachstum und Färbung von *Uca* werden mitgeteilt.

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### INDOMALAYISCHE THYSANOPTEREN III. <sup>1)</sup>

Von

H. PRIESNER,

Cairo, Aegypten.

#### Neue Gynaikothrips-Arten.

##### *Gynaikothrips brevisetis* sp.n.

♀: Braun, heller oder dunkler, Kopf dunkler als der Thorax, der Tubus schwarzbraun, nur am Ende bräunlich, jedenfalls grösstenteils dunkler als der übrige Körper. Fühler hellgelb, das 1. und 2. Glied wie der Körper gefärbt, das 8. Glied ganz schwach getrübt. Beine wie der Körper, die Vorderschienen hellgelb, am Grunddrittel getrübt, die Mittel- und Hintertibien am äussersten Ende etwas lichter oder schmal hellgelb; alle Tarsen hellgelb, mit brauner Stabendplatte. Flügel deutlich getrübt, jedoch derart, das die Ränder hyalin bleiben, also mit einem Längsstreif, der sich gegen das Flügelende allmählich erweitert und wolkig-fleckige Zeichnung hat. Die Körperborsten sind ziemlich licht.

Kopf kaum gewölbt, breit, nach hinten schwach verengt, Oberfläche rau, vorn etwas netzig, hinten querwellig, Länge 225 - 235, Breite 190 - 208  $\mu$ . Augen gross, 104  $\mu$ . Die hinteren Ocellen einander sehr nahe gerückt, ihre Entfernung vom vorderen Ocellus ist grösser als die von einander. Mundkegel sehr breit gerundet. Postokularborsten verkümmert. Fühler 450 - 467  $\mu$  lang (beim ♂ nur 400  $\mu$ ), schlank, besonders die Endglieder. Fühlergliederlängen (-breiten): 28(B.48, Sp.39), 45-48(36), 59-62(28-29), 64(33), 67(28), 70(27), 56-62(20), 42-48(13)  $\mu$ . Sinneskegel sehr lang und dünn; das 3. Glied mit nur einem, dem äusseren Kegel besetzt, der eine Länge von mindestens 50  $\mu$  besitzt. 4. Glied mit 3 Kegeln, ihre Länge ca. 55  $\mu$ , 5. Gl. mit  $2 + 1$ , 6. Gl.  $2 + 1$ . 7. Gl. 1d. Prothorax 138 - 155  $\mu$  lang, samt Coxen 328 - 372  $\mu$  breit, ohne diese 285 - 320  $\mu$  breit. Vorderrandborsten des netzig skulpturierten Prothorax sehr kurz (11), die lateralen etwa 17, die äusseren Hintereckenborsten kurz, dick, 45 - 48  $\mu$ , die inneren etwas kürzer, wie diese geknöpft. Vorderschenkel nicht verdickt, Oberfläche etwas rau, Vorderschienen und Vordertarsen einfach. Mesothorax 363 - 400  $\mu$  breit, nicht eckig vortretend. Flügel nur etwa 865 lang, nicht sehr breit, gleichbreit, mit 8 - 10 Schaltwimpern. Seiten der Abdominalsegmente schwach, aber deutlich genetzt, das 1. Segment in der Mitte genetzt. Flügelsperrdornen normal entwickelt. Die dorsalen Borsten oval geknöpft, das äussere Paar der

<sup>1)</sup> Cfr. Treubia Vol. X, p. 447; Vol. XI, p. 357.



Seitenborsten bedeutend länger als das innere, ersteres am 7. Segment 104, am 8. Segment 73  $\mu$  lang, am 9. Segment misst die geknöpfte Borste 1 : 130 - 140  $\mu$ , B.2 ist am Ende abgerundet oder fast spitzig, 168  $\mu$ , B.3 spitzig, 140  $\mu$ . Tubus 260 - 294  $\mu$  lang, gegen das Ende verengt, vor demselben noch stärker eingezogen, am Grunde 88 - 89, am Ende 43 - 46  $\mu$  breit. Terminalborsten kurz, 120 - 138  $\mu$ .

♂: Etwas schwächer als das ♀. Kopfmasze: 208 : 182. Mesothorax 346 - 363  $\mu$  breit. Fühler 400  $\mu$  lang. Gliederlängen vom 3. an: 56, 53, 53, 56, 53 - 56, 39  $\mu$ . Vordertarsen mit sehr kleinem Zähnechen. 9. Segment mit deutlicher „Schuppe“, die seitlich kaum vorspringt. B.2 des 9. Segmentes kurz, am Ende nicht ganz scharf, hyalin.

Der gedrungene Kopf, die Färbung der Tibien, der lange Tubus, die getrübbten Flügel, die hellen Fühler mit den ungewöhnlich langen und dünnen Sinneskegeln lassen die Art nur mit *G. scotti* BAGN., *decipiens* (KARNY), *convolvens* (KARNY), ferner *Eugynothrips conocephali* (KARNY) und *E. persimilis* (KARNY) vergleichen. *G. scotti* hat aber zahlreichere Schaltwimpern; *G. decipiens* ist eine viel zierlicher gebaute Art mit deutlichen Postokularborsten, ohne netzige Skulptur der Oberfläche des Körpers; *G. convolvens* kann gar nicht verwechselt werden, da sie robuster ist und viel längere, fast spitzige Prothoraxborsten hat und dasselbe gilt von *Eug. conocephali*. Am nächsten steht der neuen Art *Eug. persimilis*, doch hat diese Art stärkeren Tarsenzahn des ♂, vollkommen getrübbte Flügel, anders gestalteten Tubus und deutliche Postokularborsten.

#### Larve von *Gynaikothrips brevisetis* sp.n.

II. Stadium: Hellgelb, Pronotumplatten nicht dunkel. An den Fühlern nur das I. (ganz schwach) und das 2. Glied mit Ausnahme der Endhälfte getrübt, Trübung am 7. und 8. Glied kaum bemerkbar. Seitenplatten am 8. Segment schmal und undeutlich, 9. und 10. Segment ganz braun.

Von den Kopfborsten ist B. I der ersten Reihe 17-20, B.1. der 2. Reihe 39-42  $\mu$  lang, beide kräftig. Fühlergrubendistanz sicherlich nicht mehr als 25  $\mu$ . Fühlergliederlängen(-breiten): 17(B.36-39, Sp.34), 28-29(27), 57-59(22-24), 50-53(24), 48(22), 67(6.Gl.18, 7.Gl.11)  $\mu$ . Das 3. Glied 2.4-2.5 mal so lang als breit. Das 7. Glied vom 6. nicht deutlich getrennt. Sinneskegel am 4. Gl. stark gebogen. Am Pronotum auch B.1 (34  $\mu$ ) geknöpft; B.3: 42-45, B.4 und B.5: 36-40, B.6: 55-60, B.7: 45-50  $\mu$ . B.6 des Meso- und Metathorax stark geknöpft, 55-60  $\mu$ . Abdomen, 1. Segment, B.1: 39-42, B.2: 50, geknöpft, wie alle übrigen Dorsalborsten; 7. Segment, 45, 48, 64-67; 8. Segment, 42, 43, 50; 9. Segment, 90-98, 85, 85 (geknöpft, von der Seite gesehen lanzettlich), B.4 spitzig, ca 110  $\mu$ . 9. Segment 85  $\mu$  lang, am Grunde 100, am Ende 90  $\mu$  breit. 10. Segment ungefähr ebenso lang, am Grunde 68, am Ende 34 breit. Terminalborsten ca. 140  $\mu$  lang. Lanzettborsten schmal, nicht gegabelt. — Länge (nicht volle Länge) 1 mm.

Bei der Bestimmung nach meiner Tabelle (Treubia VIII, Suppl. 1926) kommt man auf p. 254, Leitzahl 130 und 131, *Gyn. pallicrus* KA., *Arrhenothrips*.



Unsere Art hat aber kürzere B.7 des Pronotums, auch längere B.1 des 9. Segmentes als *Arrhenothrips ramakrishnai* HOOD; die Larve des *Gynaikothrips pallicus* KARNY hat viel längere B.7 des Pronotums; zum Vergleich muss noch die Larve des *Eugynothrips intorquens* (KARNY) herangezogen werden; diese hat aber weniger gestrecktes 3. Fühlerglied, die des *Eugynothrips persimilis* (KARNY) scharf getrenntes 6. und 7. Fühlerglied.

Patria: Philippinen, Luzon, Mt. Makiling, an *Conocephalus* sp., leg. BAKER. — 12437.

### ***Gynaikothrips piperis* sp.n.**

Sehr ähnlich dem *Gynaikothrips pallipes* KARNY, so dass er leicht mit diesem verwechselt werden könnte. Die neue Art ist aber robuster, am leichtesten ist sie durch das gestrecktere Fühlerende und den längeren Kopf zu unterscheiden. Färbung wie bei *pallipes*, nur ist das Gelb der Tibien und mittleren Fühlerglieder ganz rein, während es bei *pallipes* einen ganz schwachen rötlichen Stich zeigt.

♀: Kopf 252-260  $\mu$  lang, 208  $\mu$  breit, seine Seiten kaum merklich gerundet, nach hinten viel weniger deutlich verengt als bei *pallipes*, Augen flacher, 107  $\mu$  lang. Mundkegel wie bei *pallipes*. Postokularborsten sehr lang, dunkel mit heller Spitze. Fühler 467  $\mu$  lang (bei *pallipes* nur bis 424  $\mu$ ). Fühlergliederlängen (-breiten): 34(41, Sp. 34), 53-56(31), 64(31), 73(36), 73(29), 67(27), 56(22), 29-31(11)  $\mu$ . Das 3. Glied mit 1 (äusseren), das 4. Glied mit 3 sehr langen (ca. 56  $\mu$ ), das 5. und 6. mit 2, das 7. mit 1 dorsal; bei *pallipes* messen die Sinneskegel des 4. Gliedes nur 42  $\mu$ . Prothorax 164  $\mu$  lang, samt Coxen 363  $\mu$  breit. Vorderbeine einfach, Tarsen ohne Zahn. Borsten des Prothorax lang, gebogen, am Ende mit heller Rundung oder etwas gefranst. Mesothorax 346-415  $\mu$  breit. Flügel (fast 952  $\mu$ ), länger als bei *pallipes*, in der Färbung fast genau wie bei diesem. Basalborsten der Flügel 100-106, (bei *pallipes* 76-78  $\mu$ ). Schaltwimpern 7-10. Borsten am Abdomen gelb, länger als bei *pallipes*, Lateralborsten des 7. Segmentes 154-170, des 8. Segmentes 100  $\mu$  lang, die Borsten des 9. Segmentes, B.1, 2 sind 207-225  $\mu$  lang (bei *pallipes* 173  $\mu$ ). Tubus 208  $\mu$  lang, am Grunde 87-90, am Ende 43  $\mu$  breit; die längsten Terminalborsten messen 190  $\mu$ . — Körperlänge (gedehnt) 2.5-2.68 mm (bei *pallipes* 2.05 mm).

♂: Nur etwas schwächer. Kopf 234  $\mu$  lang, Fühler 467  $\mu$ . Prothorax 130  $\mu$  lang, 328  $\mu$  breit. Fühlergliederlängen(-breiten) vom 3. Gliede an: 67-70, 73-75, 72, 67, 59, 31  $\mu$ . B.2 des 9. Segmentes höchstens 98  $\mu$  lang, Tubus 190  $\mu$  lang, am Grunde 78-81, am Ende 39  $\mu$  breit. „Schuppe“ seitlich nicht vorragend.

### Larve von *Gynaikothrips piperis* sp.n.

II. Stadium: Hellgelb, Kopfplatten kaum angedeutet, Pronotumplatten fehlen, Platten am 8. Segment schmal, 9 und 10. Segment sowie das 11. schwarzbraun. Fühlergrubendistanz 28-31  $\mu$ . Kopf an den Augen 115  $\mu$  breit. Kopfborsten lang, geknöpft, nur B.2 der 2. Reihe (20-22) spitzig. B.1 der ersten Reihe



31-34  $\mu$ , B. 1 der zweiten Reihe 53-56  $\mu$ , letztere stark gebogen. Fühler dunkel, das 3. Glied ganz dunkel, das 4. aber (mit Ausnahme des Grundes) weisslich, das 5. wenigstens am Grunde licht. Fühlergliedlängen (-breiten) vom 3. Gliede an: 90(25), 64, 50, 63-65, das 7. und 8. Glied verschmolzen. B.2 des Prothorax geknöpft, 34, B.3 ebenso, 70, B.4 62, desgleichen B.5: 112-125, haarartig, B.6 über 155, vielleicht 160, haarartig, B.7: 55, geknöpft. Diese Borsten sind dünn. Die Borsten des Meso- und Metathorax sind dünn, wie die vorigen, geknöpft (B.4 ca 55-60), nur B.6 haarartig, ca. 170  $\mu$ . Abdomen, 1. Segment, B.1: 62-65, B.2: 67-70, geknöpft; am 7. Segment nur B.1, 2 geknöpft, B.3 sehr stark gebogen, haarspitzig, über 170  $\mu$  lang; 8 Segment B.62, 67  $\mu$ . 9. Segment, B.1, 2, 3: 98  $\mu$  lang, geknöpft, B.4 spitzig. Das 9. Segment 90 - 103  $\mu$  lang, am Grunde 93 - 105, am Ende 78 - 91  $\mu$  breit. 10. Segment 81 - 91  $\mu$  lang, am Grunde 62 - 73, am Ende 31 - 34  $\mu$  breit. Terminalborste nicht messbar.

Bei der Bestimmung nach meiner Tabelle (Treubia, VIII, Suppl.) erreicht man Leitzahl 164, *Gynaikothrips pallipes*. Das mir vorliegende Material an *G. piperis*-Larven ist nun leider zu gering, dass es gelänge, sichere Unterschiede gegenüber *pallipes* herauszufinden. Ich glaube aber, dass diese vorhanden sind, nur scheint es mir, dass das *pallipes*-Material (l.c.p. 190) kein reines war; dass ich dort schon beide Larvenarten vermischt hatte, da ja die vorliegenden Imagines meiner damaligen Meinung nach alle gleich waren, was ich heute nicht mehr feststellen kann, da ich die Tiere nicht mehr alle hier habe. Aus dieser Möglichkeit der Konfundierung konnte sich auch meine Mitteilung von der grossen Variabilität der *Gynaikothrips pallipes*-Larven (in der Borstenform z.B.) erklären. Von den wirklichen *piperis*-Larven habe ich nur 4 Exemplare vor mir, von denen nur eines einen ganzen Fühler trägt, zwei liegen lateral, so dass ich zu keinem sicheren Urteil gelangen kann. Eines ist aber sicher, dass nämlich alle diese Stücke zwar schwach, aber deutlich geknöpfte B.7 des Prothorax haben; ich wäre also nach dem bisherigen zur Meinung geneigt, dass die (l.c.) erwähnten *pallipes*-Stücke mit geknöpfter B.7 hierher zu ziehen sind, und dass man die beiden Arten vielleicht durch dieses Merkmal im Larvenstadium unterscheiden könnte.

### ***Gynaikothrips eugeniae* sp.n.**

♀: Bräunlichschwarz bis schwarz. 1. und 2. Fühlerglied wie der Körper gefärbt, das 3. bis 6. hellgelb, das 6. am Ende ganz schwach getrübt, das 7. in der Endhälfte, das 8. ganz (hell) braungrau. Schenkel wie der Körper, Tibien und Tarsen hellgelb. Flügel fast hyalin, nur die vorderen äusserst schwach angeraucht, bei einigen Stücken aber fast ganz hell. Borsten dunkel, am Abdomen hell, Terminalborsten dunkel.

Kopf 260-294  $\mu$  lang, 190-208  $\mu$  breit, demnach etwa 1.4 mal so lang als breit. Wangen gerade, nach hinten ganz leicht verengt. Mundkegel breit gerundet. Augen 120  $\mu$  lang. Postokularborsten etwa 43  $\mu$  von den Augen entfernt, sehr



kurz, seitlich nicht vorragend, dunkel, am Ende hell. Fühler 605  $\mu$  lang, schlank, das 4. Glied viel länger und dicker als das 3. Fühlergliederlängen(-breiten); 34, 56(31), 76-84(34), 98-104(42), 98-109(31), 93-98(28), 76-84(18), 42(11)  $\mu$ . Das 4. Glied stark verdickt, von der Verdickung an stark konvergierend zur Spitze verengt. Sinneskegel ungewöhnlich lang, noch am 5. Glied 84, am 6. 76  $\mu$ . Endglied dicht (seitlich gesehen schräg) an das 7. anschliessend, am Grunde nicht verengt. Prothorax 138-155  $\mu$  lang, ohne Coxen 330  $\mu$  breit. Vordereckenborsten gut entwickelt, Ende wie das der anderen Borsten stumpf; Lateralborsten lang, Hintereckenborsten etwa 130  $\mu$  lang (beim ♂ 104-120  $\mu$ ). Vorderbeine einfach, Vordertarsen ohne Zahn. Pterothorax 372-406  $\mu$  breit. Flügel gleichbreit, Basalborsten dunkel, fast spitzig. Schaltwimpern 8-12 (meist 9-10). Die gelben Borsten des Abdomens sind fast spitzig, am 9. Segment vollkommen spitzig, die letzteren mindestens 210  $\mu$  lang. Terminalborsten etwa bis 260  $\mu$  lang. Tubus 242-260  $\mu$  lang, am Grunde 81-90, am Ende 42-45  $\mu$  breit. — Körperlänge (gedehnt), 2.4-2.6 mm.

♂: Vom ♀ nicht wesentlich verschieden, bei einer Kopflänge (-breite) von 260(190)  $\mu$ , ist der Tubus 216  $\mu$  lang. B.2. des 9. Segmentes kurz, dennoch aber sehr gut entwickelt (ca. 62  $\mu$ ). 9. Sternit nur wenig vorgezogen, seitlich kaum vorragend.

Bei der Bestimmung nach KARNYS Tabelle der gelbschienigen *Gynaikothrips*-Arten (Mem. Dept. Agr. Ind., Ent. Ser., IX, 6, 1926, p. 234-237) erreicht man Leitzahl 9: *G. siamensis* KARNY und *G. daetymon* KARNY. Von *G. daetymon* ist die neue Art durch viel kräftigere Fühler, deren mittlere Glieder nicht einmal 3mal so lang als breit sind, im übrigen aber längere Fühler, besonders aber durch längere Prothorax-Borsten (die bei *daetymon* dick aussehen und nur 70  $\mu$  lang sind) verschieden; äusserst ähnlich ist *G. siamensis*; diese Art hat aber ebenfalls kürzere Prothoraxborsten (84  $\mu$ ), kürzere Fühler (6. Glied 73  $\mu$ ), auch sind die Borsten am 9. Segment beim ♂ von *siamensis* dunkler als beim ♂ des *eugeniae*, der Mundkegel ist bei *siamensis* etwas zugespitzt, während er bei *eugeniae* abgerundet ist.

Patria: Malacca, Kuala Lumpur, 24.IX.1920, in Blattgalle No. 2b an *Eugenia* spec., leg. DOCTERS VAN LEEUWEN.

### ***Gynaikothrips ficarius* sp.n.**

♂: Schwarz. Vorderschienen braungelb, an den Rändern dunkel, Mittel- und Hintertibien ganz dunkel, nur die Tarsen der Mittel- und Hinterbeine gelblich wie die der Vorderbeine. Die beiden ersten Fühlerglieder dunkel, wie der Körper, das 3. und 4. Glied rein hellgelb, das 5. Glied am Ende (doch vielleicht nicht immer) ganz schwach getrübt, das 6. Glied ungefähr in der Endhälfte (sicher undeutlich) getrübt, das 7. und 8. Glied ganz graubraun. Flügel an der Basis hyalin; hinter den 3 Basalborsten beginnt ein starker dunkler Längsstreif, der übrigens etwa von der Flügelmitte an von einer Trübung des



gesamten Flügels begleitet ist. Hinterflügel mit Längsstreif, in der Endhälfte schwach getrübt.

Kopf 294  $\mu$  lang, 212  $\mu$  breit, fast 1.4 mal so lang als breit. Augen 113-121  $\mu$  lang, innen etwas ausgerandet, die hinteren Ocellen liegen etwas vor der Mitte der Netzaugen. Wangen nach hinten geradlinig etwas verengt, Mundkegel gerundet. Postokularborsten deutlich, die Kopfseiten deutlich etwas überragend, ungefähr so lang wie ein Auge, dunkel, wie sämtliche übrigen stärkeren Körperborsten (auch die des Abdomens), am Ende mit hyaliner Spitze. Abstand der Postokularborsten vom Hinterrande der Augen 35, Abstand von einander 138  $\mu$ . Fühlergliederlängen (-breiten): 36(B.42, Sp.35), 53-56(29-31), 84(32), 90(39), 84(34), 76(11), 64(22), 36(12)  $\mu$ . Das 3. Glied mit 1, das 4. mit 4 Sinneskegeln, am 3. Glied sind diese 40, am 5. etwa 56 lang. Das 8. Glied am Grunde nicht deutlich verengt, dort etwa parallelschief. Prothorax 138  $\mu$  lang, ohne Coxen 303, samt Coxen 355  $\mu$  breit. Vordereckenborsten sehr gut entwickelt (schätzungsweise 70  $\mu$  lang), wie die übrigen mit plötzlich heller Spitze; von den übrigen sind die inneren posteromarginalen 100, die äusseren 118-125  $\mu$  lang. Vorderbeine ganz wenig verdickt, Vordertarsen ohne Zahn. Pterothorax 400  $\mu$  breit. Vorderflügel (gegen das Ende etwas verengt, in der Mitte nicht verengt), mit 14-18 Schaltwimpern. Die Borsten am Abdomen sehr dunkel, am Ende mit heller Spitze, Lateralborsten des 7. Segmentes 118  $\mu$  lang, des 8. Segmentes etwas kürzer, B.1 und 3 des 9. Segmentes 260-277  $\mu$  lang, B. 2 (Stachelborste) etwa 70  $\mu$  lang. Tubus 250-260  $\mu$  lang, am Grunde 87, am Ende 48  $\mu$  breit. Terminalborsten 225-240  $\mu$  lang. Körperlänge 2.3-2.8 mm (etwas gedehnt).

♀: Etwas kräftiger, Mesothorax etwa 0.48-0.5 mm breit. Kopf 328-363  $\mu$  lang, 234-260  $\mu$  breit. Tubus 303-328  $\mu$  lang, am Grunde 104, am Ende 52  $\mu$  breit. Die längeren Borsten des 9. Segmentes (B.2, 3) 311  $\mu$  lang. An den Fühlern kann bei dem einzigen Stück nur das 4. und 5. Glied gemessen werden, es ist 101(41), bzw. 93(31)  $\mu$  lang (breit). — Körperlänge von 2.38 (etwas zusammengezogen) bis 3 (normale Länge, aber grosses Stück) mm.

Vergleicht man die bisher bekannten *Gynaikothrips*-Arten mit langem Tubus, so führen die mit Längsstreif versehenen, getrübten Flügel und die Färbung der Fühler nur auf die Arten *maximus* KARNY und *nigripes* KARNY; die erstere der beiden Arten hat kürzeren Kopf, deutlich gedrungenere Fühler und gleichmässiger (auch an der Basis stärker) getrübte Flügel; *G. nigripes* hat entschieden kürzeren Kopf (268 : 216  $\mu$ ), längere Postokularborsten und geringere Zahl Schaltwimpern (10), auch dunklere Vorderschienen, dunklere Tarsen, überdies viel weniger schlanke Beine. Von den Arten, bei denen der Tubus deutlich kürzer ist als der Kopf, kommen für den Vergleich nur jene in Betracht, die getrübte Flügel haben: *atavus* KARNY und *primitivus* KARNY haben spindelförmiges 8. Fühlerglied; *tristis* KARNY kürzeren Tubus und dicke Knopfborsten des Vorderkörpers; *chavicae* (ZIMMERMANN) hat ganz helle Vorderschienen und schon an der Basis getrübte Flügel; von den Arten mit lichterem Fühlern kommt nur *longiceps* KARNY für den Vergleich in Betracht, denn *leeuweni* KARNY, *simillimus* KARNY und *cognatus* KARNY haben gleichmässig getrübte Flügel, keinen Längs-



streif und *rectigenis* KARNY hat parallele Kopfseiten. *G. longiceps* ist aber durch die völlig abweichenden relativen Masze hinlänglich verschieden, überdies sind die Flügel auf der ganzen Fläche bräunlich angeraucht, dann ist der Kopf bei *longiceps* 350  $\mu$  lang und 24  $\mu$  breit.

Patria: Singapore,  $\pm$  25 m, 17.IX.1920; in Blattgalle (No. 18) an *Ficus benjamina* L., leg. DOCTERS VAN LEEUWEN.

### **Gynaikothrips retusae** sp.n.

♀: Schwarz, Beine ebenso, Vordertibien braungelb, Aussen- und Innenränder schmal dunkel, Tarsen gelb (aber nicht sehr licht; Endplatte dunkel). Die beiden ersten Fühlerglieder dunkel, das 3. Glied hellgelb, am Ende schwach getrübt, das 4. nur in der Grundhälfte hellgelb, übrigen (besonders oben) deutlich getrübt, das 5. ungefähr ebenso gefärbt, am 6. Glied etwas weniger als die Grundhälfte hellgelb, 7. und 8. Glied braun. Die Trübungen der mittleren Fühlerglieder sind nicht sehr stark. Vorderflügel in der Basalhälfte (mit Ausnahme der braunen Borstenplatte) hyalin, in der Endhälfte deutlich getrübt, überdies wenigstens in den zwei Enddritteln mit braunem Längsstreif, der aus kleinen Makeln zusammengesetzt ist, und der vor der Spitze erlischt. Hinterflügel ähnlich gefärbt, aber nicht viel ausgedehnter als im Enddrittel getrübt, gleichfalls mit Längsstreif, der aber schmal und nicht aus Makeln zusammengesetzt ist. Körperborsten, auch die des 9. Segmentes schwarz.

Kopf lang (342  $\mu$ ) mit grossen Augen, 252  $\mu$  breit, samt Interantennalfortsatz etwas über 1.4 mal, sonst 1.36 mal so lang als breit, von den Augen, die eine Länge von 130 - 132  $\mu$  haben, deutlich geradlinig nach hinten verengt, am Hals nur 216  $\mu$  breit. Die hinteren Ocellen etwas vor der Mitte der Netzaugen. Postokularborsten gut entwickelt, schwarz, sicher nicht länger als ein Auge. Mundkegel mässig breit, gerundet. Fühler 657-674  $\mu$  lang, ähnlich gebaut wie bei *mikaniae*; das 3. Glied nicht genau messbar, da es etwas schräg liegt, vermutlich 112(34)  $\mu$  lang (breit), mit 1 Sinneskegel (aussen), das 4. Glied 112(42)  $\mu$  lang (breit), mit 3 + 1 Sinneskegeln, die langen Sinneskegel gut 56  $\mu$  lang; die übrigen Glieder: 109(36), 100(34), 78(27), 42(14)  $\mu$ . Vorderschenkel kaum verdickt, Vordertarsen ohne Zahn. Prothorax 225  $\mu$  lang, ohne Coxen 424, samt diesen 502  $\mu$  breit. Coxenborste 95  $\mu$  lang, wie alle übrigen Borsten schwarz. Vordereckenborsten gut entwickelt, ca. 87  $\mu$ , innere Vorderrandborsten kleiner, Lateralborsten 113, Posteromarginalborsten 156  $\mu$  lang; diese Borsten haben blasse Spitze, sind nicht geknöpft und kaum gebogen. Mesothorax ca. 520  $\mu$  breit; Metathorax nach hinten etwas gerundet verengt. Flügel gleichbreit, 1.44 mm lang, mit 18 - 20 Schaltwimpern. 2. Abdominalsegment 520  $\mu$  breit. Borsten am Abdomen durchwegs dunkel, am 8. Segment messen die längsten 145  $\mu$ , am 9. Segment B. 1-3: 329-346, alle spitzig oder fast so. Tubus 346  $\mu$  lang, ebenso lang wie der Kopf, am Grunde 113, am Ende 52  $\mu$  breit, nach hinten geradlinig,



vor der Spitze unmerklich stärker verengt. Terminalborsten 277-295  $\mu$  lang. — Körperlänge (gedehnt) 2.62 mm.

Patria: Penang, Malacca, 28.IX.1920, *Ficus retusa* L. No. 33 „Gewoon; bladgal niet gedroogd“, No. 107; leg. DOCTERS VAN LEEUWEN.

Bemerkung. Ich war nicht in der Lage, die *Gynaikothrips*-Arten: *G. citricornis* MOULT., *G. kuwayamai* MOULT., und *G. rotundus* MOULT., sämtlich aus Formosa zum Vergleich heranzuziehen, da ich leider noch nicht in den Besitz der betreffenden Beschreibungen gelangt bin.



## A NEW RACE OF CYORNIS FROM THE JAVA SEA

by

F. N. CHASEN and C. BODEN KLOSS

(Raffles Museum, Singapore).

### **Cyornis rufigastra longipennis** subsp. nov.

Like *C. r. rufigastra* (RAFFLES) of the Malay Peninsula and Borneo but larger: perhaps less bright above and below in both sexes: this different tint, however, may be due to a bleaching effect of the marine climate in which the bird lives and not truly represent the real colour of the feathers.

*Type*. — Adult male, collected on Karimon-Java Island, Java Sea, 15th May, 1926, by Dr. K. W. DAMMERMAN, No. 4012.

*Specimens examined*. — 2 adult males, 3 adult females and 2 juvenile females, all from the Karimon-Java Islands, compared with thirty-six examples from the Malay Peninsula, Rhio Archipelago, Sumatra (one), and Borneo — all of which we regard as *C. r. rufigastra*: and six skins from Sebesi Island in the Sunda Strait which may represent *rhizophorae* of STRESEMANN. (cf., Bull. Raffles Mus., No. 2, 1929, p. 39).

*Remarks*. — The wings of the small series of adults before us measure ♂ 80, 82 (type); ♀ 75, 77 and 79 mm. This range seems sufficiently distinct from that of *C. r. rufigastra* in which the wing gives a range of 71 - 77 mm in males and 68 - 73 mm in females. The islands of the Bornean area seem to produce the largest birds among those we regard as *rufigastra*: and two from Banguay Island, North Borneo have the wing measuring male 80, female 74 mm (t.c.s., p. 37).

The wing measurements given by ROBINSON and KINNEAR <sup>1)</sup> for their *C. b. beccariana* (= our *C. r. rufigastra*) are exactly the same as those given by us for a different series <sup>2)</sup>.

A large form, at present only known by one male, also occurs in the Karimata Islands, off south west Borneo. This is *C. r. karimatensis* OBERHOLSER: it is stated to have the underparts of an deep colour. Birds from Banka Islands (*calocephala* OBERH.) and those from the mainland of Java (*rhizophorae* STRESE.) are small.

We are indebted to Dr. DAMMERMAN, Director of the Zoological Museum, Buitenzorg, Java, for the opportunity of examining these skins.

<sup>1)</sup> Nov. Zool., XXXIV, 1928, p. 245.

<sup>2)</sup> Bull. Raffles Mus., No. 2, 1929, p. 37.







## HERPETOLOGISCHE NOTIZEN. <sup>1)</sup>

Von

Dr. F. KOPSTEIN,

(Bandoeng, Java).

### III. Reptilien des östlichen Preanger (West-Java).

Zur Förderung der Kenntnis der vertikalen und horizontalen Verbreitung der Reptilien auf Java seien hier die Fundorte jener Reptilien mitgeteilt, die ich in den Jahren 1925/1929 in der weiteren Umgebung von Tasikmalaja und Garoet, den beiden Hauptorten der Residenz Ost-Preanger sammelte resp. beobachtete. Ost-Preanger (auf den holländischen Karten Oost-Priangan) liegt im äussersten Osten der Provinz West-Java, deren Süd-Ost-Ecke sie darstellt, wobei der Tjitandoeij Fluss die Grenze gegenüber der Provinz Mittel-Java bildet. Als Fundorte werden bloss Namen angeführt, die in den meisten Karten im Masstabe von 1 : 250.000 aufgenommen sind. In jenen wenigen Fällen, wo es nötig schien, auch andere Namen zu nennen, wird in Klammern auf den am nächsten gelegenen Ort verwiesen, der wohl in den Übersichtskarten 1 : 250.000 zu finden ist (wobei noch bemerkt werden muss, dass oe der holländischen Schreibweise = u). In der Nomenklatur folge ich aus Utilitätsgründen bis zum Erscheinen meiner Revision dem Kataloge De Rooy's "Reptiles of the Indo-Australian Archipelago".

#### OPHIDIA.

<i>Typhlops lineatus</i> BOIE.	Tasikmalaja, 350 m;
<i>Typhlops braminus</i> DAUD.	Tasikmalaja, 350 m; Garoet, 700 m;
<i>Python reticulatus</i> SCHNEIDER.	Tasikmalaja, 350 m; Rantjah, 450 m;
<i>Python molurus</i> L. ( <i>bivitatus</i> WERNER).	Tasikmalaja, 350 m; Pameungpeuk, 10 m;
<i>Dendrophis pictus</i> GMEL.	Tasikmalaja, 350 m; Tjibeber, 150 m; Rantjah, 450 m; Kalipoetjang, 20 m; Pangandaran, 2 m; Maroko, 50 m; Tjisompet, 450 m;
<i>Dendrophis formosus</i> BOIE.	Tjikatomas, 250 m; Tjipatoedjah, 10 m; Rantjah, 450 m;
<i>Zaocis carinatus</i> GTHR.	Tjisompet, 450 m;
<i>Tropidonotus piscator</i> SCHNEIDER.	Tasikmalaja, 350 m; Tjiawi, 500 m; Garoet, 700 m; Rantjah, 450 m;

<sup>1)</sup> Cfr. Treubia Vol. X, p. 467; Vol. XI, p. 301.



<i>Tropidonotus trianguligerus</i> BOIE.	Tasikmalaja, 350 m; Garoet, 700 m;
<i>Tropidonotus chrysargoides</i> GTHR.	Tasikmalaja, 350 m; Garoet, 700 m;
<i>Tropidonotus vittatus</i> L.	Tasikmalaja, 350 m; Garoet, 700 m; Rantjah, 450 m; Singaparna, 400 m;
<i>Tropidonotus subminiatus</i> SCHLEGEL.	Tasikmalaja, 350 m; Garoet, 700 m; Rantjah, 450 m; Kalipoetjang, 20 m;
<i>Tropidonotus chrysargus</i> SCHLEGEL.	Garoet, 700 m;
<i>Zamenis korros</i> SCHLEGEL.	Tasikmalaja, 350 m; Garoet, 700 m; Tjikatomas, 250 m; Tjiawi, 500 m; Kalipoetjang, 20 m; Rantjah, 450 m; Singaparna, 400 m; Tjidjoelang, 5 m;
<i>Coluber melanurus</i> SCHLEGEL.	Tasikmalaja, 350 m; Rantjah, 450 m; Garoet, 700 m; Kalipoetjang, 20 m;
<i>Coluber radiatus</i> SCHLEGEL.	Tasikmalaja, 350 m; Garoet, 700 m; Rantjah, 450 m; Singaparna, 400 m;
<i>Coluber oxycephalus</i> BOIE.	Kalipoetjang, 20 m; Rantjah, 450 m; Tasikmalaja, 350 m;
<i>Lycodon subcinctus</i> BOIE.	Kawali, 450 m; Deudeul, 400 m; Tjiawi, 500 m; Garoet, 700 m; Sembawa, (Deudeul), 800 m; Kalipoetjang, 20 m;
<i>Simotes purpurescens</i> SCHLEGEL.	Karangnoengal, 250 m;
<i>Oligodon bitorquatus</i> BOIE.	Dajeuhmangoeng, (Garoet), 1000 m;
<i>Elapoides fuscus</i> BOIE.	Dajeuhmangoeng, (Garoet), 1000 m;
<i>Ablabes baliodirus</i> BOIE.	Dajeuhmangoeng, (Garoet), 1000 m;
<i>Calamaria vermiformis</i> D.B.	Dajeuhmangoeng, (Garoet), 1000 m;
<i>Calamaria lumbricoidea</i> BOIE.	Dajeuhmangoeng, (Garoet), 1000 m;
<i>Calamaria virgulata</i> BOIE.	Dajeuhmangoeng, (Garoet), 1000 m;
<i>Calamaria linnaei</i> BOIE.	Dajeuhmangoeng, (Garoet), 1000 m; Tji-soeroepan, 1300 m;
<i>Hypsirhina enhydris</i> SCHNEIDER.	Kalipoetjang, 20 m; Padaherang, 10 m;
<i>Homalopsis buccata</i> L.	Kalipoetjang, 20 m;
<i>Dipsadomorphus multimaculatus</i> BOIE.	Tjikatomas, 250 m; Pameungpeuk, 10 m;
<i>Dipsadomorphus dendrophilus</i> BOIE.	Rantjah, 450 m; Parigi, 10 m; Tjisompet, 450 m; Kalipoetjang, 20 m;
<i>Dipsadomorphus nigriceps</i> GTHR.	Tjikatomas, 250 m; Tjikalong, 20 m;
<i>Dipsadomorphus jaspideus</i> D.B.	Soekaradja, 250 m;
<i>Psammodynastes pulverulentus</i> BOIE.	Garoet, 700 m; Bantarkalong, 200 m; Papandajan, 1400 m;
<i>Dryophis prasinus</i> BOIE.	Parigi, 10 m; Rantjah, 450 m; Kalipoe-tjang, 20 m;



<i>Dryophiops rubescens</i> GRAY.	Pangandaran, 2 m;
<i>Bungarus fasciatus</i> SCHNEIDER.	Tasikmalaja, 350 m; Rantjah, 450 m; Garoet, 700 m;
<i>Bungarus candidus</i> L.	Tasikmalaja, 350 m; Garoet, 700 m; Rantjah, 450 m;
<i>Naja tripudians sputatrix</i> .	Tasikmalaja, 350 m; Garoet, 700 m; Kalipoetjang, 20 m; Parigi, 10 m; Tjiawi, 500 m; Bandjar, 40 m;
<i>Doliophis intestinalis</i> BOIE.	Manondjaja, 300 m; Tjikatomas, 250 m; Garoet, 700 m; Parigi, 10 m;
<i>Amblycephalus carinatus</i> BOIE.	Tjikatomas, 250 m; Kalipoetjang, 20 m;
<i>Lachesis gramineus</i> SHAW.	Parigi, 10 m; Rantjah, 450 m; Bandjar, 40 m; Tjiawi, 500 m; Singaparna, 400 m; Kalipoetjang, 20 m; Parigi, 10 m;
<i>Lachesis puniceus</i> BOIE.	Dajeuhmangoeng (Garoet), 1000 m;
<i>Hydrus platurus</i> L.	Pangandaran (Süd-Küste).

## LACERTILIA.

<i>Gymnodactylus marmoratus</i> KÜHL.	Tasikmalaja, 350 m; Garoet, 700 m;
<i>Gymnodactylus fumosus</i> F. MÜL.	Kawah Kamodjan (Garoet), 1400 m;
<i>Hemidactylus frenatus</i> D.B.	von der Küste an überall bis 1300 m;
<i>Gehyra mutilata</i> WIEGM.	von der Küste an überall bis 1300 m;
<i>Hemiphyllodactylus typus</i> BLKR.	Tasikmalaja, 350 m;
<i>Gecko verticillatus</i> LAUR.	Pameungpeuk (Küste).
<i>Gecko monarchus</i>	Tjipatoedjah, 10 m; Tasikmalaja, 350 m;
<i>Draco volans</i> L.	Tasikmalaja, 350 m; Pendjaloe, 700 m; Pangandaran (Küste);
<i>Gonyocephalus chamaeleontinus</i> LAUR.	Pamekatan (Garoet), 1300 m;
<i>Gonyocephalus kuhli</i> SCHLEGEL.	Kawah Kamodjan (Garoet), 1400 m;
<i>Calotes jubatus</i> D.B.	Tasikmalaja, 350 m; Garoet, 700 m;
<i>Calotes tympanistriga</i> GRAY.	Kawah Kamodjan (Garoet), 1400 m;
<i>Varanus nebulosus</i> GRAY.	1 Ex. bei Tasikmalaja gekauft;
<i>Varanus salvator</i> LAUR.	Tasikmalaja, 350 m; Pangandaran (Küste); Bandjar, 40 m; Tjibalong, 150 m; Pameungpeuk (Küste);
<i>Tachydromus sexlineatus</i> DAUD.	Tasikmalaja, 350 m; Bandjar-Wangi (Garoet), 650 m;
<i>Mabuia multifasciata</i> KÜHL.	überall von 0 - 1300 m;
<i>Mabuia quinquecarinata</i> WERNER.	Kawah Kamodjan (Garoet), 1400 m;
<i>Lygosoma sanctum</i> D.B.	Padaherang, 50 m;
<i>Lygosoma temmincki</i> D.B.	Kawah Kamodjan (Garoet), 1400 m; Garoet, 700 m;
<i>Lygosoma chalcides</i> L.	Kawah Kamodjan, 1400 m;



## CHELONIA.

*Cyclemys dhor* GRAY.Karangnoengal, 250 m; Bantarkalong,  
200 m;*Chelonia mydas* L.

Pangandaran, Pameungpeuk;

*Trionyx cartilagineus* BODD.

Tasikmalaja, 350 m; Garoet, 700 m;

## EMYDOSAURIA.

*Crocodylus porosus* SCHN.

Kalipoetjang, 10 m; Pameungpeuk, 2 m.



## NOTES ON THE FAUNA OF PULAU BERHALA

by

J. C. VAN DER MEER MOHR

(Medan).

### Introduction.

In November 1925 the author and his friend Dr. L. FULMEK paid a short visit to Pulau Berhala. As a result of this trip it was decided to make a more extended faunistical survey of the island as soon as circumstances would permit. So in 1926 I went again to Pulau Berhala and stayed there for a week (21-28 August). In working out the various collections made during this second visit, it was deemed necessary to complete them and to fill up some gaps in the observations on the biology of the green turtle, *Chelonia mydas*. Consequently, in 1927 I once again went to the isle of Berhala and remained there from 7-17 August. In the same year a short visit was also paid at Christmas time with the chief purpose of obtaining data on bird migration, but in this respect the results of this fourth trip were rather disappointing.

Except for a few stray notes relating to the collections which MJÖBERG, F. C. VAN HEURN and CORPORAAL brought back from their visit to Pulau Berhala in 1919, I am not aware that there has been published anything else on the fauna of the island, though from a letter of Mr. BODEN KLOSS, Director of Museums S.S. and F.M.S., I gather that in 1920 members of the F.M.S. Museums did also some collecting on Pulau Berhala. Therefore the following notes are chiefly based on the collections and observations made by myself; but of course, references are duly made to the recent work of DAMMERMAN concerning the fauna of the isles of the Krakatau group and of Pulau Durian and the Rhio Lingga archipelago and to the various publications of British naturalists on the fauna of the Aroa and other islands situated in the Straits of Malacca. The results of my second and third collecting trip have already partly been published (cf. Bibliography).

The faunistical exploration of Pulau Berhala was rendered feasible by the financial support of the Indisch Comité voor Wetenschappelijke Onderzoekingen (Netherland Indies Committee for Scientific Research) to whom my acknowledgements are due. Furthermore, I have to tender my sincere thanks to Prof. DOCTERS VAN LEEUWEN, Director of 's Lands Plantentuin, Dr. DAMMERMAN, Director of the Zoological Museum and Dr. BEUMÉE, Director of the Herbarium, for their cordial co-operation and assistance and to all of those specialists who have kindly assisted me in identifying the collections.



### Topographical and historical notes.

Pulau Berhala is the name given to a group of two little islands (fig. 1) situated in the Straits of Malacca some 50 miles due east of Belawan (Port of Medan). Its shortest distance to the mainland of the East Coast of Sumatra is about 21 miles (see accompanying map, fig. 2). From Tandjong Bringin or Bandar Chalipah in the district Padang and Bedagei it can be viewed with the naked eye if weather is fine. Both islands are composed of granite (cf. Bibl. 10, p. 99-100) <sup>1)</sup>.

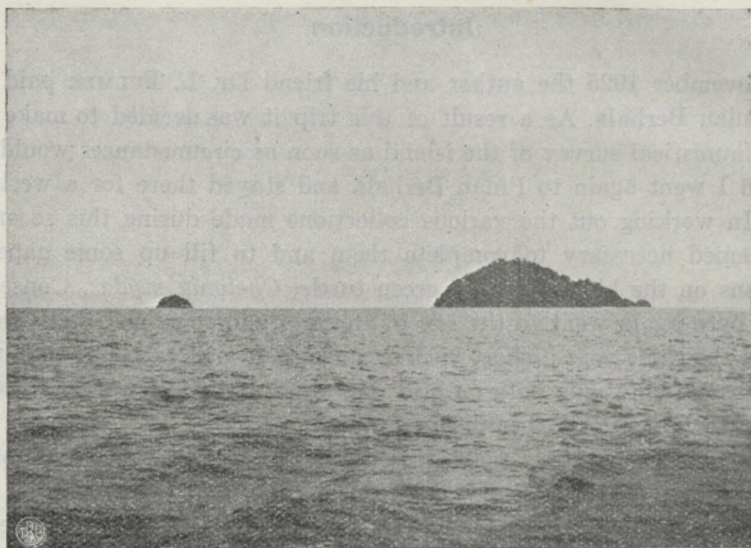


Fig. 1. Pulau Berhala (from SW).

<sup>1)</sup> I am indebted to Dr. DRUIF, geologist at the Deli Tobacco Experiment Station, Medan, who visited Pulau Berhala in December last year, for the following comments on the geology of that island.

„The islet consists chiefly of granite. Only between the main part and the „Staart” there are some layers of gneiss with one dyke of pegmatite (size about 1½ m). The granite is medium coarse, a few specimens however have been collected which show porphyric structure. The mineral composition varies little; by microscopical determination Orthoclase, Microcline, some Albite, Quartz and Biotite were found. Zircon is abundant while some Apatite and Garnet were also observed. Interesting is the occurrence of several minerals of pneumatolitic origin: Tourmaline, Dumortierite and Monazite. A few crystals of Casiterite could be isolated. Another most interesting fact lies in the occurrence of older rocks as inclusions in the granitic body. Quartzite and Zoisite-quartzite could be identified. By weathering the granite gives birth to a light red coloured loamy-sandy soil with very little organic matter. On some spots lateritic decomposition was observed, yielding a yellowish-red, heavy, loamy soil. The dense jungle does not allow an extensive search for diaclasses or other tectonical features, but the coast shows at least in one case the result of folding movements. Measurements taken on the gneiss did result in: Fall 42 degrees, strike N 30 E. The granite of the „Staart” has developed cleavage as illustrated by the wellknown „plate” form. There can be little doubt that Pulau Berhala forms part of the same batholithic intrusion that everywhere in this part of Malaysia brought the Tin-ores of highly economic importance.



Collecting has only been done on the largest of the two islets. This islet — Pulau Berhala proper — rises abruptly from the sea to an altitude of 135 m as indicated by my aneroid whereas on the Dutch Admiralty chart its altitude is given as 178 m. It is more or less pentagonally shaped and covers an area of approximately 36 ha (90 acres). One of the sides of the pentagon is formed by the sandy beach on the S-side of the island, extending in a direction approximately W.-E. By a rocky promontory this beach is divided into two parts, of which the eastern and longest part is favoured by *Chelonia mydas* to perform its egg-laying operations. Isolated from the main island by a narrow strip of sand, which is submerged at high tide but otherwise dry, and opposite to its SE-point lies a wooded mass of rocks (fig. 3) which, for convenience' sake, may be called the "Staart" in this article and which attains a height of some 20 m. At a distance of approximately half a mile NW of Pulau Berhala proper lies the second islet of the group, a mere rock crowned with some vegetation and utterly devoid of a beach. The S-side of the main island is fringed by a coral reef (fig. 4), making landing directly on this side of the island somewhat difficult and quite impossible of course at low water. The "Staart" and the main island form a little bay, open to the NE, which at high tide affords a good landing place for vessels like the native sampan or chinese tongkang. The island offers no other suitable landing place, for its E, N and W-sides, surrounded by huge

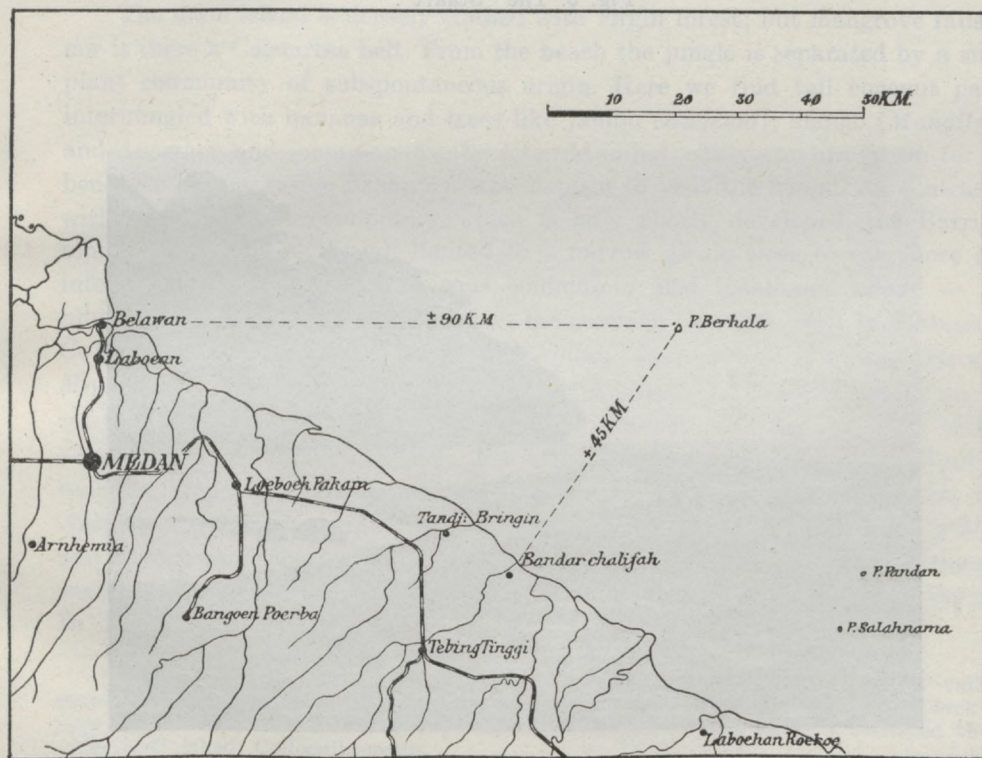


Fig. 2. Map of Sumatra's East Coast.



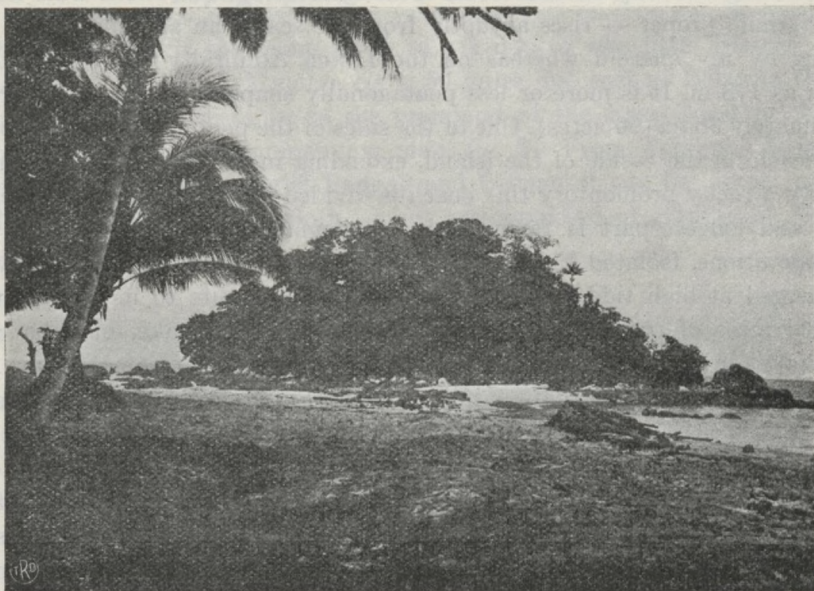


Fig. 3. The "Staat".



Fig. 4. Part of the shore at low water with coral reef (from E).



granite boulders whereon the swell is always pounding, slope steeply into the sea. The depth of the sea between Pulau Berhala and the Sumatra Coast does not fully reach 30 fathoms.

The main island is only temporarily inhabited by Malays, who visit the island chiefly on account of the eggs of the green turtle which are dug up, preserved and sold at the nearest mainland markets. Chinese fishermen sometimes call at Pulau Berhala if weather is too bad for fishing, or if their fresh-water supply needs replenishing. Some tumble-down huts stand just within the shelter of the promontory dividing the beach into two parts. Following the path which runs over this rocky projection, we arrive after a 5 minutes walk at the place where one of the rivulets, by which the island is watered, comes out on the beach and where the Malays have built a primitive bathing place (panchoran) by diverting the stream over an aquaduct made of split-up bamboos. Here water seems always obtainable, even in very dry years as in 1926. Another path — fainter and running first through a stony rivulet beyond the native encampment, afterwards following mostly a ridge — leads directly inwards and to the highest point of the island. Halfway one can make a halt near a huge boulder from where a splendid view of the sea may be had. From this point a side path, first steep downwards then steep upwards, leads to a narrow cave, a breeding place of swifts <sup>1)</sup>.

The main island is densely clothed with virgin forest; but mangrove fails <sup>2)</sup>, nor is there a Casuarina belt. From the beach the jungle is separated by a small plant community of subsponaneous origin. Here we find tall coconut palms intermingled with bananas and trees like jambu (*Eugenia*), mango (*Mangifera*) and *Averrhoa* and some papaws; here too Manihot, chilly etc. are grown for the benefit of those native fishermen who happen to visit the island. As contrasted with the *Pescaprae* community which is only poorly developed, the *Barringtonia* community — though limited to a narrow girdle close to the shore and interrupted by the subsponaneous community just mentioned above — exhibits a fair development. It comprises the common elements, such as *Terminalia Catappa*, *Barringtonia speciosa*, *Calophyllum Inophyllum*, *Hibiscus tiliaceus*, *Morinda citrifolia*, *Erythrina* etc. At several places, in close proximity to the sea, the rocks are covered with groups of *Pandanus tectorius* and tufts of tall palms (*Oncosperma filamentosa*). The mixed forest largely consists of Euphorbiaceous elements such as *Galearia filiformis*, *Trigonostemon longifolius* and *Antidesma montanum* intermingled with big specimens of *Ficus*, *Myristica* and *Artocarpus*. The undergrowth is chiefly composed of Rubiaceae elements, such as *Psychotria sarmentosa*, *Pavetta Indica* and *Lasianthus cyanocarpus*. In the ravines an Aroid, *Schismatoglottis calypttrata*, abounds.

<sup>1)</sup> The little island N of Pulau Berhala proper possesses a fine and rather deep cave, running inwards from a mouth situated at sea level. Owing to lack of time I could only make a very superficial inspection of this cave; I collected there some unfinished *Collocalia*-nests.

<sup>2)</sup> Some mangrove elements, however, occur on the island viz. *Excoecaria agallocha*, *Heritiera littoralis* and *Caropa obovata*.



Historical data concerning Pulau Berhala are of course very scarce. Some were kindly furnished to me by Mr. L. C. HEYTING, a Government Civil Officer. The island appears on an old Chinese map of the year 1430. In times of Portuguese mastery it was known as *Illha Polvoreiro* (Varela). In the Karo-Batak dictionary of JOUSTRA, Pulau Berhala is said to be the place where Datuk Roembija Gande, a well known magician, has his abode. According to the narrative of a Malay fishermen I met on Pulau Berhala, this island once was the residence of a very devout Datuk who, after the death of his wife, departed and settled on another island (Pulau Datuk = Pulau Jarak?). The grave of his wife on the "Staart" afterwards became a place of pilgrimage ("kramat").

What, however, is still more important in connection with the fauna of Pulau Berhala is the fact that in 1899 the Deli Tobacco-Growers Association erected there a quarantine station for Chinese immigrants, but this occupation lasted for a short time only, the barracks afterwards being completely abandoned (cf. Bibl. 22, p. 92-93). It seems quite plausible that the coconut trees and plantains, which at present border the beach, were planted during the time the island was occupied for quarantine purposes.

### The Fauna.

Before reporting in detail upon the different faunistical groups, it seems advisable to put forward a few remarks on some of the factors which have a distinct bearing on the composition of the fauna of Pulau Berhala, though some interesting phenomena remain utterly unexplained by them, and also on the circumstances under which the faunistical exploration of the island has been carried out.

Perhaps the most important ecological factor is the smallness of the island (Pulau Berhala proper not exceeding 90 acres) thus excluding all those forms which, in a wild state, require much vaster areas.

An other factor of ecological importance is the type of vegetation with which the island is covered. Now Pulau Berhala is forested from its base up to its very highest point mainly by dense but monotonous virgin jungle as has already been pointed out in the foregoing chapter. This monotony of the flora explains why fauna-elements, which are exclusively confined to such biotopes like grassy plains or mangrove swamps, are entirely wanting, though occasionally one may have the luck to meet on the island such an element, probably on errand.

A third factor is the lack of stagnant fresh-water pools of any extensive proportions, fresh-water life therefore being confined to the few rivulets trickling down the damp, rocky ravines and forming minute cascades and shallow water-holes in the rainy season, but almost dry in rainless periods.

Though there is a more or less constant intercourse between Pulau Berhala and the opposite mainland and though the island has served for a time as a



quarantine station, the influence of both factors, with some exceptions which will be discussed later on, is, I think, on the whole rather insignificant.

As already mentioned before, two visits of longer duration were paid to the island (in 1926 and 1927 resp.) but both times in the same month viz. August. Therefore a fair impression of seasonal changes in the fauna of the island could not be obtained. In this connection I will refer to the rather puzzling seasonal difference in the occurrence of (non migratory) birds and butterflies as noticed by DAMMERMAN during his subsequent visits to Pulau Durian. Besides, in 1926, the East Coast of Sumatra suffered from abnormal drought during the period February-July which also may have influenced in many respects the fauna of Pulau Berhala, especially its invertebrate fauna.

On both visits the method of trapping by lamp light was employed but it did not yield the results expected by me. This, to a certain degree, must be ascribed to the fact that there was a full moon on both occasions that I stayed at the island, but beyond doubt the prevailing fairly strong wind also had a marked influence on the lamp catches.

It was not possible for me to practice systematically the method of soil-sifting. Only two samples (one gathered at 50 m above sea-level, the other near the beach) were sifted but seemed rather poor.

It goes without saying that if in the following there is any question of either the absence or presence on Pulau Berhala of an element of a special faunistical group, one has to bear in mind that for small and inconspicuous forms there is always the possibility that they have been overlooked and they may be discovered on a later occasion. But if such forms like squirrels and frogs or even forms like the Rhinoceros beetle and the red ant *Oecophylla smaragdina*, the presence of both of which is readily to be noticed (of the one by the characteristic damage to its foodplant and of the other by its large-sized leafy nests), have repeatedly not been observed, one may safely assume that indeed they do not belong to the present fauna of the island.

### Mammals.

Only 4 species were caught, 2 of which may have been introduced, viz. *Tragulus kanchil*, the largest terrestrial mammal of the island, and *Pachyura murina*. The latter is the common musk shrew of human buildings, but on Pulau Berhala it is far from numerous. In fact we did not trap a single specimen in 1926 and only 4 or 5 specimens in the following year.

If we may believe the Malay fishermen the mouse deer is only a recent introduction. Some 20 or 30 years ago a Rajah of Padang and Bedagei went on pilgrimage to Pulau Berhala and on that occasion took with him a score of live mouse deer; at his arrival these creatures were released as a kind of ritual performance which the Malays call "bajar nijat". In this respect the presence of the "kramat" on the "Staart" already mentioned before supports in some degree the credibility of the story.



Rats (*Rattus r. neglectus*)<sup>1)</sup> are very numerous, at least in the vicinity of the Malay encampment and cause a great deal of damage to the coconut trees by boring holes in the unripe nuts. In the forested inner part of the island I could scarcely discover any trace of these rodents. I think it quite possible that our common Malay house rat (*Rattus r. diardi* JENT.) was introduced to the isle of Berhala when this served as a quarantine station, but that for some reason or other it could not survive the struggle for life (cf. Bibl. 6, p. 291-292). It certainly would be a very interesting experiment to introduce the house rat once more to Pulau Berhala with a view to giving it a fair chance to establish itself once more on the island and to keep an eye from time to time on how this species will manage there in the future. It seems worth mentioning that Pulau Jarak, which lies only some 40 miles E of Pulau Berhala, between this island and the Dindings (Malacca coast), has a species of rat, viz. *R. r. jarak* (cf. Bibl. 1 and 36) which differs slightly from *R. r. neglectus*. Is it by no means easy to understand by what special factor this subspecific difference has originated since area, climate and vegetation of both islands are almost identical.

As far as I could ascertain no other bats than *Pteropus hypomelanus fretensis* live on the island. In December 1927 when I paid a short visit to Pulau Berhala a big dadap tree on the beach opposite the "Staart" was in flaming bloom and each night the "kluangs" gathered there to feast on its buds and young pods. I never saw the flying foxes undertake nightly migrations. One might expect to find also insectivorous bats on Pulau Berhala; but I think I am right when I say there are none.

A puzzling feature with regard to the mammalian fauna of Pulau Berhala, which struck me every time I visited the island, is the total absence of monkeys and squirrels. If monkeys and squirrels inhabited the island in olden times — and why should this not have been so? — the question arises immediately for what reason have they disappeared. At all events the lack of these notorious nest robbers is all-important to bird life on Pulau Berhala.

### Birds.

In the course of my subsequent visits altogether 15 species of birds have been collected while 7 more species were only seen but not shot. To these 22 species I must add two more, viz. *Ninox scutulata*, of which a specimen was caught by F. C. VAN HEURN in November 1919 (cf. Bibl. 45, p. 97) and a *Pitta* observed by him at the same time (letter of 19th July, 1928), making up the sum total of 24 species as against 29 species recorded by ROBINSON and BODEN KLOSS for the neighbouring island of Jarak (cf. Bibl. 39).

A fact which struck me when I visited Pulau Berhala in December 1927, touches upon the paucity of migratory species observed at that time in comparison with the abundance of migrants met with by ROBINSON and BODEN KLOSS

<sup>1)</sup> *R. r. neglectus* (JENT.) = *Mus r. jalorensis* BONH., the Malay fieldrat (cf. DAMMERMAN in Treubia, X, 2-3, 1928, p. 307-308.).



on the other islands in the Straits of Malacca (Pulau Jarak, Aroa Islands and the One Fathom Bank Lighthouse) when they collected there in the month of November 1918 and 1919. Mr. BODEN KLOSS, on questioning him about this point, kindly informed me that he thinks it possible "that most of the migrants travel down the Malacca side of the Straits or are attracted by the larger and less forested Aroa Group" (letter of 20th January, 1928).

A remarkable feature of the avifauna of Pulau Berhala is the total absence of woodpeckers, and some other groups (Timeliidae, Dicaeidae<sup>1)</sup>) which one is reasonably inclined to expect there.

*Haliaetus leucogaster* breeds on Pulau Berhala; an enormous nest of this white-bellied sea eagle was sighted in the bare top of a lofty forest tree. In August 1926 I shot at a *Haliaetus* sitting on a branch but missed or only wounded the bird. As it flew away it let drop from its claws a snake, undoubtedly a sea snake (cf. Bibl. 27).

MJÖBERG (cf. Bibl. 21), who visited the island on two different occasions, found bird life exceedingly rich, kingfishers and pigeons being dominant. Now by pigeons in all probability is meant *Myristicivora bicolor* which, like *Caloenas nicobarica*, is a characteristic denizen of our smaller islands. Large flocks of the pied imperial pigeon daily visited the same fruit trees to which they returned time after time with regular intervals. I never saw them in the crowns of the coconut palms as did BODEN KLOSS on Pulau Babi, Great Nicobar (B. KLOSS, In the Andamans and Nicobars, p. 157). As I observed the Nicobar pigeon during August as well as in December, it is most likely resident. Of the pink-headed fruit dove, *Ptilopus jambu*, a single immature example was shot at dusk in August 1927. I think the bird had just arrived as it behaved rather drowsily. Kingfishers, in contradiction to MJÖBERG'S statement, I found to be far from numerous. The ruddy kingfisher, *Halcyon coromandus*, was only once seen, viz. in November 1925.

The commonest bird on Pulau Berhala, at least during my stay in August 1926, was the Koel, *Eudynamis malayana*. In August 1927, however, it seemed to me that these birds were not nearly so abundant.

*Collocalia* (perhaps *innominata*) was found breeding in the caves at both islands (cf. p. 281), though at the time I visited these caves only a few nests (without eggs) of this swift were obtained.

Both sunbirds, *Cinnyris hasselti* and *Anthreptes malaccensis*, are common islanders. They were always seen fluttering in the crowns of the coco palms around the spikes and alternately visiting the flowering jambu trees. Especially as *A. malaccensis* is dependant on the presence of coconut palms, we cannot wonder that it was not found on Pulau Jarak since this entirely uninhabited island is devoid of coconut trees as Mr. BODEN KLOSS wrote to me.

*Motacilla melanope* was observed both times I visited the island in the summer months, but in 1927, at Christmas time, there were none to be seen.

<sup>1)</sup> In consequence no Loranths, the dissemination of which is performed by Dicaeids eating the viscid fruits, were noticed.



*Hirundo gutturalis* was always present. *Calornis chalybea* was only once noticed (August 1927). A small flock alighted on a fig tree near the shore for a short time and then disappeared; afterwards no other examples were seen or heard.

According to the Malay fishermen the frigate birds (probably *F. ariel*) roost on the small islet north of the main island. The same informants told me that the Rajah of Padang and Bedagei, who is said to have introduced the kanchils (cf. p. 283), also brought with him some specimens of *Streptopelia tigrina*, the Malay spotted dove. It is no wonder, however, that these doves could not establish themselves there as this species affects open country.

### Reptiles and Amphibians.

The naturalist who visits Pulau Berhala is very likely to be impressed by the abundance of lizards met with everywhere. Both *Aphaniotis acutirostris* and *fusca* are very numerous in the jungle proper, whereas *Mabuia rudis* and *Lygosoma olivaceum* may be seen fairly often amongst the shrubbery along the beach. According to the observations of HOPE SWORDER on Pulau Senang and Johore Bahru (cf. Bibl. 42), which agree very well with those of KOPSTEIN on Amboina, Saparua etc. (cf. Bibl. 16), *Lygosoma atrocostatum* is in its habitat confined to the seashore "between high and low water mark", seeking refuge in "old tree stumps on the beach, the drift wood along high water mark and in crevices in the rocks" when the tide comes in. I regret that I have not spent more time in observing the habits of this interesting species which, like *Lygosoma bowringi*, is still not yet known from Sumatra though both species have also been found by DAMMERMAN on the isles of the Krakatau group. The same naturalist also mentions *L. atrocostatum* from Pulau Durian, Rhio Lingga archipelago.

In 1926 we made a diligent search in the few tumble-down huts near our camp but in spite of our efforts and money offered to the Malays for "chichaks", not a single specimen of the commoner species of house geckos was discovered; a strange fact indeed for which I cannot give a reasonable explanation since, in 1927, we not only caught several specimens of *Lepidodactylus lugubris* and *Gecko monarchus* there, but also some specimens of a *Hemidactylus*, which proved to be new to science (*H. vandermeer-mohri*). Of *Gecko monarchus* a specimen was also captured in the jungle, far away from the native dwellings; when hunting in the jungle we often heard the characteristic call of the "tokeh" (cf. also KOPSTEIN on the habits of *Gecko verticillatus*. Bibl. 16, p. 79).

*Varanus salvator*, the monitor lizard, may be seen at low water crawling over the sun-scorched bare rocks along the seashore as well as in the damp, cool forest ravines. Si Alang, an intelligent Malay fisherman I met at Pulau Berhala in 1927, informed me that on several occasions he had come across the "menjawak" swimming out to sea as did JACOBSON in May 1908 (cf. Bibl. 11, p. 197).



The sole snake found on Pulau Berhala was a fine specimen of *Dipsadomorphus dendrophilus*, the ular tiung, which was captured at night by one of the native's huts <sup>1)</sup>. It appeared to be parasitized by *Amblyomma helvolum*. If my Malay informants are right in their statement no other species of snakes occur on the island.

As has already been mentioned, *Chelonia mydas* is a regular visitor of the sandy beach of Pulau Berhala. The two sea snakes inserted in the list of reptiles and amphibians on p. 293 were both captured alive, *Hydrophis* in the densest part of the forest, *Enhydris hardwickei* in the shrubbery along the shore. In my opinion in both cases we have to consider the snakes as a lost prey of *Haliaetus leucogaster* (cf. Bibl. 27).

The Amphibians are — strange to say — simply and solely represented by *Ichthyophis glutinosa* of which the eel-like larvae live concealed in the mud of the two rivulets referred to in the chapter dealing with the topography of the island. Neither frogs (*Rana*) and tree-frogs (*Rhacophorus*), nor toads were ever seen or even heard by us.

## Insects.

### HYMENOPTERA.

More than 15 species of ants have been collected on Pulau Berhala (see list p. 294). A surprising feature of the antfauna of the island is the absence of *Oecophylla smaragdina*, the big red ant which builds up its leafy nests with the aid of its larvae. As the ferocious species is very common in the coastal districts of the East Coast of Sumatra, it is rather difficult to understand why it is not present on Pulau Berhala whereas two other species viz. *Dolichoderus bituberculatus* and *Plagiolepis longipes*, both of which are also very common in the coastal plains, are well represented on the island. I should here point out that JACOBSON (cf. Bibl. 11, p. 200) has found *O. smaragdina* on Krakatau together with several species of *Polyrhachis*, the latter genus also being represented on Pulau Berhala by at least 2 species.

Of other Hymenoptera I will mention the occurrence of *Xylocopa latipes*, a species of *Megachile* and a Scoliid wasp, which latter, however, I failed to catch. The presence of the leafcutter bee was demonstrated by the characteristic marginal cuttings in the leaves of several shrubs.

### COLEOPTERA.

Of the more conspicuous forms caught by the lamp I mention *Batocera albofasciata*, *Monohammus fistulator*, *Macronota malabariensis*, *Mimela debilis* <sup>2)</sup> and a fine green, gold-sprinkled Buprestid. Especially the two first-named species came very readily to the lamp. *Oryctes rhinoceros*, the common pest of

<sup>1)</sup> Another example of *D. dendrophilus* was captured by some members of a party who visited the island in December 1929.

<sup>2)</sup> I have to thank Dr. LEEFMANS for the identification of these 4 species; the remaining material is still wanting examination.



coconut trees, is entirely absent on Pulau Berhala and the chance that from the opposite mainland a rhinoceros beetle will ever arrive on the island by the wing is, I think, very slight, but it is not quite so improbable that some *Oryctes*-larvae may accidentally arrive with drifting cocoons trunks. I have no doubt that the other notorious cocoons pest, the red palm weevil (*Rhynchophorus ferrugineus*) is also absent. The plantains along the shore are heavily infested by a species of *Cosmopolites*, probably *sordidus*. This weevil has almost certainly been introduced by means of corms which people imported from the mainland, though it is not at all improbable that it has arrived on the island by means of floating plantain stems as this weevil species can resist immersion in water (at least fresh water) for several days (cf. WALTERS, Viability of the weevil *Cosmopolites sordidus* etc. in Rept. Agr. Dep. St. Lucia, 1925 (Trinidad, 1926), p. 8).

#### LEPIDOPTERA.

Butterflies seem to be very scarce, a few Lycaenids and some Pierids (*Terias hecabe* and a species of *Catopsilia*) being the only representatives of the rich rhopalocerous fauna of Sumatra's East Coast which we could collect at Pulau Berhala. Moths must be far better represented though our lamp-catches yielded rather poor results in this respect owing to the circumstances referred to above (p. 283). I noted a fine example of *Nyctipao* in the forest and a *Cephonodes* hovering by the flowers of *Scaevola frutescens*.

It is perhaps worthy of note that the plantains along the beach show no sign whatever of attack by the common leaf-roller, *Erionota thrax*.

#### DIPTERA.

Though near by our camp on the beach there were some puddles of fresh water and the numerous flower sheathes of the coconut palms which had dropped down furnished many suitable breeding places for mosquitos, these were not troublesome owing to the everlasting cool breeze. In the jungle, however, there were plenty. A nuisance, especially to my native taxidermist, were the small greyish flies, enlivening the shore. A big Asilid was also collected.

On *Wedelia biflora* the common bud galls caused by a Trypetid were found. The presence of gall midges was noted by their galls <sup>1)</sup> on *Heritiera littoralis*, *Terminalia Catappa*, *Leea indica*, *Melothria* sp. and *Ficus* sp. div.

#### HEMIPTERA.

Concerning this order one gets the impression that it is very poorly represented. A Gerrid skims the rivulets. At the lamp were caught a species of *Polytoxus* (probably *P. fusco-vittatus*), a Cydnid (*Scoparipes* ? *longirostris*) and a Mononychid. *Cantao ocellatus* was found on a shrub along the shore.

<sup>1)</sup> Some of the galls mentioned in this paper have already previously been recorded by DOCTERS VAN LEEUWEN-REYNVAAN and DOCTERS VAN LEEUWEN (The Zoocccidia of the Netherlands East Indies) from material collected on Pulau Berhala at an earlier date.



Of Fulgorids 3 species have been identified viz. *Pochazia fuscata*, *Nogodina plena* and *Pseudoryza carinata*. The shrill song of a singing cicada was sometimes heard in the forest but I failed to get a live specimen.

Of Aphids I can only mention a species producing galls on *Wedelia biflora* and another one (perhaps not identical with the foregoing) on *Justicia Gendarussa*. A Coccid was found on a species of *Vitex* (?). The leaves of the jambu tree (*Eugenia* sp.) near the eastern panchoran were strewn with the galls of a Psyllid.

#### ORTHOPTERA.

The richness of Pulau Berhala in Orthoptera, at least with regard to individuals, is very striking. The same holds good with regard to spiders and since both groups constitute, I presume, the main food of lizards one cannot wonder at the abundance of the latter (cf. p. 286).

Altogether 22 species have been identified by KARNY. In 1926 a few specimens closely resembling *Valanga nigricornis* were noticed feeding on cocos leaves but we failed to catch them; in 1927 however I did not see any again. Strangely to say neither Mantoids nor Phasmids were found. Perhaps the most interesting find is *Xiphidion cognatum*, a species which hitherto had only been recorded from Borneo and Amboina.

We never discovered specimens of the common cockroaches (*Periplaneta americana* and *australasiae*) in the native dwellings though both species certainly must have had over and over again a good opportunity for invading the island, but it seems that these true house-hold pests cannot stand their ground there, though the reasons why are still not very clear to me since at least *P. australasiae* was found by DAMMERMAN on the isle of Krakatau. According to MALCOLM BURR (Fauna and Geography of the Maldive and Laccadive Peninsulas, I, p. 234) *P. americana* is "common throughout the Maldives, infesting the larger boats, but seldom found ashore". In August 1927 an introduction "en masse" happened when directly after landing in the morning I unpacked a case filled with rice and swarming with cockroaches, viz. *P. americana*, owing to the fact that my boy had left it open on board the night before. I think it worth while for any naturalist who in future may visit Pulau Berhala, to take special pains in trying to discover if the cockroaches have really succeeded in establishing themselves.

#### ODONATA.

Dragon flies are — or at least were during all my visits — exceedingly scanty. In fact we only sighted some 3 or 4 specimens at a time. In March 1929 when I paid a 10 minutes visit to Salanama, an island of much the same size as Pulau Berhala and lying halfway between that island and the Aroa group (off Tandjong Balei), dragon flies were quite plentiful whereas on Pulau Berhala, where we landed an hour later, the almost total absence of Odonata was



very evident. Perhaps the fact that the isle of Salanama is only partly forested and has more open ground than Pulau Berhala may account for this difference in the occurrence of Odonata on both islands. According to Mr. LIEFTINCK, of the Buitenzorg Museum, who kindly identified the material, the 2 species found on Pulau Berhala are *Ischnura senegalensis* and *Rhyothemis phyllis*, both common species. Of the former species a male and female were caught in copula.

#### ISOPTERA.

In the Berhala fauna termites obviously do not form such a striking feature as is the case on Pulau Durian according to DAMMERMAN (l.c. p. 287). This, perhaps, must be ascribed to the fact that the soil is rather poor in organic matter as, owing to the steepness of the island, considerable masses of vegetable mould are always carried away during the rainy seasons (cf. also note on p. 278).

Only very scanty material of the remaining insect orders being available I must refrain from dealing here with those orders.

#### Arachnids and Myriopods.

REIMOSER has described 13 species of spiders from Pulau Berhala (cf. Bibl. 33), but since this number is only based on the collection made in August 1926 we may safely assume that the number of species is indeed higher. In 1927, for example, I caught some *Gastracanthas* which I looked for in vain in 1926. The most remarkable find is *Laches sundaica* since all the other species of this genus are restricted in their distribution to the Mediterranean.

As is the case with other faunistical groups, the spider fauna of Pulau Berhala too is characterised by the absence of some of the most common and widespread elements viz. the large *Heteropoda venatoria* and *Uloborus geniculatus* which both are frequenters of human habitations. Concerning the latter species it is, however, possible that it is contained in the collection made in 1927 which has not yet been worked by REIMOSER<sup>1)</sup>.

With regard to the Scorpions and Myriopods I regret that I cannot report upon them here in detail as the material brought from Pulau Berhala is still wanting examination.

As for Acari one should consult the list on p. 296. Of gall-producing species at least 4 were observed viz. on *Terminalia Catappa*, *Wedelia biflora*, *Pavetta* sp. and *Nephrolepis hirsutula*.

#### Crustacea.

Since the terrestrial Isopods collected on Pulau Berhala have not yet been studied I can only deal here with some of the larger forms of land crustaceans inhabiting the island. In this respect the occurrence of *Sesarma ocyroda* is most

<sup>1)</sup> Since this was written the paper of REIMOSER dealing with the whole collection of spiders from Pulau Berhala has been published (cf. Bibl. 34). It appears from his paper that indeed *U. geniculatus* does not occur on the island. In total 27 species were identified.



interesting. This little crab was found in both rivulets where it hides in holes and underneath stones or among roots and rotten leaves. Here too may be mentioned the find of a young male of *Metasesarma rousseauxi*; it was collected above high watermark on a tree trunk that had broken down. The biggest representative of the crustaceous fauna of the island is *Gecarcoidea lalandii* which has its refuge amongst the roots of some large forest tree or in rock crevices. It seemed to me that in August 1926 this species was far more numerous than in August 1927. It surely is an astonishing fact that with regard to the Dutch East Indian archipelago this species was — up to its discovery on Pulau Berhala — only recorded from one other locality, viz. the Bay of Gorontalo (Celebes) (cf. Bibl. 18).

The shore is alive with numbers of *Ocypoda ceratophthalma* and in the jungle, up to the highest point of the island, hermit crabs (*Coenobita*) find their way. The rôle these notorious scavengers play in the economy of as small an island as Pulau Berhala must certainly not be underrated (cf. BORRADAILE in Fauna and Geography of the Maldivé and Laccadive Peninsulas, I).

### Mollusca.

Apart from those forms like *Melampus* and *Pythia* which are more or less semi-marine in that their habitat is restricted to the shore, 7 species of land- and only one species of fresh-water molluscs were collected on Pulau Berhala. The fresh-water species, *Melania tuberculata truncatula*, was found in the brook near the western panchoran.

In my note on the molluscs of the island (cf. Bibl. 23) it was stated that *M. t. truncatula* had not been recorded up till then from the opposite mainland but this, evidently, is erroneous since PRASHAD (cf. Bibl. 32) already mentioned this species from Sumatra where DEN DOOP has found it at several places. Moreover, a renewed examination of my *Opeas*-material makes the presence of *O. javanicum* on Pulau Berhala very doubtful since the specimens formerly identified as *O. javanicum* belong in fact to *O. gracile*; thus the idea of *O. javanicum* being introduced from Java to Pulau Berhala by bird's agency must be dropped (cf. also Bibl. 12, p. 141).

*Diplommatina calcarata* was collected by sifting the humus of a large epiphytic *Asplenium*-fern; in this substratum specimens of *Opeas gracile* were also found. *Omphalotropis dohertyi* and *Alycaeus frühstorferi* were picked from between the rotten leafsheathes of decaying plantains as was also the case with the specimens of *Lagochilus*. Here too *O. gracilis* and *Prosopaeas achatinaceum* occur.

From the list of DEGNER (cf. Bibl. 9) it appears that *A. frühstorferi* and *D. calcarata* are not yet known from Sumatra but a more detailed malacological investigation of the East Coast will no doubt reveal their presence there. Both species are recorded from West Java. In 1927 I also collected a slug (*Sem-perula*?) but owing to some mishap I lost the tube with its contents.



### Vermes.

Two species of earth-worms are mentioned by MICHAELSEN, viz. *Perionyx violaceus* and *Pontoscolex corethrurus* (cf. Bibl. 19). Both are peregrine forms, the latter species moreover circummundane. *P. corethrurus* was also found by DAMMERMAN on Pulau Durian, Rhio Lingga-archipelago (cf. Bibl. 20). It is quite probable, however, that in my own collection some more species are represented but this collection has not yet been examined <sup>1)</sup>.

Leeches do not occur on Pulau Berhala. A single specimen of a land planarian was found crawling among rotten plantain leaves, but owing to bad preservation it got lost. It measured approximately 15 cm; its colour was pale brown with a longitudinal black dorsal line.

### List of Mammals from Pulau Berhala.

(identified by Messrs. N. CHASEN and C. BODEN KLOSS)

*Tragulus kanchil* subsp.

*Rattus rattus neglectus* (JENT.)

*Pachyura murina* (LINN.)

*Pteropus hypomelanus fretensis* KLOSS.

### List of Birds from Pulau Berhala.

(species not marked have been identified by Mr. H. C. SIEBERS;  
those marked \* were only seen but not collected by the author).

<i>Haliaeetus leucogaster</i> GM.	XI-1925, VIII-1926, VIII-1927, XII-1927.
<i>Ninox scutulata</i> (RAFFL.) <sup>2)</sup>	XI-1919 (?).
<i>Halcyon chloris</i> BODD.	VIII-1926, VIII-1927.
* „ <i>coromandus</i> (LATH.)	XI-1925.
<i>Alcedo bengalensis</i> GM.	VIII-1926.
<i>Hierococcyx fugax</i> (HORSF.)	VIII-1926.
<i>Eudynamis malayana</i> CAB. & HEINE	XI-1925, VIII-1926, VIII-1927, XII-1927.
<i>Surniculus lugubris brachyurus</i> STRESEM.	VIII-1927.
* <i>Collocalia</i> sp.	VIII-1926, VIII-1927.
<i>Alseonax latirostris</i> (RAFFL.)	VIII-1926, VIII-1927.
<i>Cinnyris hasselti</i> (TEM.M.)	VIII-1926, VIII-1927, XII-1927.
<i>Anthreptes malaccensis</i> (SCOP.)	VIII-1926, VIII-1927, XII-1927.
<i>Hirundo gutturalis</i> SCOP.	XI-1925, VIII-1926, VIII-1927, XII-1927.

<sup>1)</sup> Since the manuscript was finished a note on the oligochaete fauna of P. Berhala was published by STEPHENSON (cf. Bibl. 41).

<sup>2)</sup> Cf. p. 284.



<i>Motacilla melanope</i> PALL.	VIII-1926, VIII-1927.
<i>Limonidromus indicus</i> (GM.)	VIII-1926.
* <i>Calornis chalybea</i> HORSF.	VIII-1927.
<i>Pitta</i> sp. <sup>1)</sup>	XI-1919 (?).
<i>Ptilopus jambu</i> (GM.)	VIII-1927.
<i>Myristicivora bicolor</i> (SCOP.)	XI-1925, VIII-1926, VIII-1927, XII-1927.
<i>Caloenas nicobarica</i> (L.)	VIII-1926, VIII-1927, XII-1927.
* <i>Tringoides hypoleucus</i> (L.)	VIII-1926, VIII-1927, XII-1927.
* <i>Ardea sumatrana</i> (RAFFL.)	XII-1927.
* <i>Demiegretta sacra</i> GM.	VIII-1927, XII-1927.
* <i>Fregata</i> sp.	VIII-1926, VIII-1927, XII-1927.

### List of Reptiles and Amphibians from Pulau Berhala.

(the Reptiles have been identified partly by Dr. J. K. DE JONG and partly by L. BRONGERSMA, the Amphibians by Dr. L. F. DE BEAUFORT).

#### Reptilia.

- Gymnodactylus* sp.  
*Hemidactylus vandermeer-mohri* BRONGERSMA  
*Lepidodactylus lugubris* (D.B.)  
*Gecko monarchus* (D.B.)  
*Aphaniotis acutirostris* MODIGL.  
     " *fusca* (PTRS.)  
*Calotes cristatellus* (KUHL)  
*Varanus salvator* (LAUR.)  
*Mabuia rudis* BLGR.  
*Lygosoma olivaceum* (GRAY)  
     " *atrocostatum* (LESS.)  
     " *bowringi* (GTHR.)  
*Chelonia mydas* (L.)  
*Dipsadomorphus dendrophilus* (BOIE)  
*Hydrophis* sp.  
*Enhydris hardwickei* (GRAY)

#### Amphibia.

- Ichthyophis glutinosa* (L.)

The following species which have been found on Pulau Jarak (Cf. Bibl. 42) are mentioned here for comparison: *Gecko verticillatus* LAUR., *Mabuia multifasciata* (KUHL) and *Lygosoma olivaceum* (GRAY).

<sup>1)</sup> Cf. p. 284.



**List of Ants from Pulau Berhala.**(identified by Dr. A. STÄRCKE)<sup>1)</sup>

- Bothroponera rufipes* JERDON.  
*Ectomomyrmex annamitus* ER. ANDRÉ v. *arcuata* FOREL.  
*Euponera* (*Brachyponera*) *jerdoni* FOREL.  
*Odontomachus haematoda* LINNÉ.  
*Sima pilosa* F. SMITH.  
*Crematogaster* (*Orthocrema*) *biroi* MAYR v. *andelis* SANTSCHI.  
       "              "              *millardi* FOREL.  
       "              "              *treubi* EMERY.  
*Monomorium floricola* JERDON.  
*Dolichoderus* (*Hypoclinea*) *bituberculatus* MAYR.  
       "              "              "              v. *bornensis* FOREL.  
*Technomyrmex* sp.  
*Atopodon meermohri* STÄRCKE.  
*Anoplolepis longipes* JERDON.  
*Paratrechina* (*Nylanderia*) *taylori* FOREL.  
*Camponotus* (*Tanaemyrmex*) *irritans* F. SMITH subsp.  
       "              (*Myrmablys*) *reticulatus* ROGER v. *bedoti* EMERY.  
       "              (*Colobopsis*) *vitreus* F. SMITH v. *oebalis* FOREL.  
*Polyrchachis* (*Myrma*) *mayri* ROGER.  
       "              (*Myrmhopta*) *phyllophila* F. SMITH.

**List of Hemiptera from Pulau Berhala.**

(identified partly by Mrs. R. KARNY and partly by Dr. D. MAC GILLAVRY)

- Cantao ocellatus* THNB.  
*Scoparipes ?longirostris* SIGN.  
*Gerris* sp.  
*Polytoxus* sp.  
*Mononyx* sp. (larva).  
*Pochazia fuscata* FABR.  
*Nogodina plena* WALK.  
*Pseudoryxa carinulata* SCHMIDT (?).

**List of Orthoptera from Pulau Berhala.**

(identified by Dr. H. H. KARNY)

- Gryllacris signifera* (STOLL) subsp. *obscura* BRUNNER v. W.  
*Rhaphidophora* spec. juv.  
*Euscirtus concinnus* (DE HAAN)

<sup>1)</sup> The species which Mr. CORPORAAL collected on Pulau Berhala in November 1919 and which have been identified by Mr. SANTSCHI (cf. Bibliography, 44) are also enumerated in this list.



*Cardiodactylus philippinus* BOLIVAR?

*Ornebius* spec.

*Nemobius* spec.

*Psyra melanonota* STÅL

*Isopsera chaseni* KARNY

*Phyllomimus ampullaceus* (DE HAAN)

*Xiphidion cognatum* REDTENBACHER

*Oxya sinensis* (WALKER)?

*Atractomorpha crenulata* (FABRICIUS)

*Erucius apicalis* (WESTWOOD)

*Panesthia angustipennis* (ILLIGER)

*Pycnoscelus surinamensis* (LINNAEUS) (Cosmopolitan).

*Periplaneta americana* (LINNAEUS) (only in luggage of the author).

*Pseudophoraspis nebulosa* (BURMEISTER)

*Rhcnoda rugosa* BRUNNER V. W.

*Eoblatta notulata* (STÅL)

*Blattella* (s.l.) 3 spp. indet.

### List of Spiders from Pulau Berhala.

(identified by Dr. E. REIMOSER)

*Macrothele maculata* (THOR.)

*Ariadna snellemani* (HASS.)

*Scytodes marmorata* L. KOCH.

*Zelotes javanus* (KULCZ.)

*Chiracanthium rupicola* (THOR.)

*Olios acolastus* (THOR.)

„ *lutescens* (THOR.)

*Heteropoda sumatrana* THOR.

*Thelcticopis orichalcea* (SIM.)

*Parhedrus fasciatus* REIMOSER

*Cryptothele sundaica* THOR.

*Laches sundaica* REIMOSER

*Lycosa rabulana* THOR.

*Ctenus robustus* THOR.

*Bavia sexpunctata* (DOL.)

*Cosmophasis thalassina* (C. L. KOCH)

*Plexippus paykulli* (AUD.)

*Laufeia eucola* (THOR.)

*Rhomphaea irrorata* THOR.

*Miagrammopes albomaculatus* THOR.

„ *cambridgei* THOR.

*Leucauge ventralis* (THOR.)

*Orsinome vethi* (HASS.)



*Cyrtophora moluccensis* (DOL.)  
*Cyclosa bifida* (DOL.)  
*Aranea lugubris* WALCK.  
*Gasteracantha mammosa* C. L. KOCH

### List of Acari from Pulau Berhala.

(identified by Dr. A. C. OUDEMANS)

*Meritaspis calcaratus* HIRST 1923, on *Pteropus hypomelanus fretensis* KLOSS.  
*Amblyomma helvolum* C. L. KOCH 1844, on *Dipsadomorphus dendrophilus* (BOIE).  
*Haemaphysalis traguli* OUDMS. 1928, on *Tragulus kanchil* subsp.  
*Tritia corporaali* OUDMS. 1926.  
*Allothrombium vandermeermohri* OUDMS. 1928.

### List of non-marine Molluscs from Pulau Berhala.

(identified partly by Miss T. VAN BENTHEM JUTTING and partly by Dr. F. HAAS)

*Trichochloritis crassula* (PHIL.)  
*Prosopeas achatinaceum* (PFR.)  
*Opeas gracile* (HUTTON)  
*Lagochilus* or *Adelomorpha* sp.  
*Alycaeus frühstorferi* MÖLLDFF.  
*Diplommatina calcarata* MÖLLDFF.  
*Omphalotropis dohertyi* ALD.  
*Pythia* spp.  
*Melampus fasciatus* DESH.  
*Melania tuberculata* var. *truncatula* (LAM.)

### List of Oligochaeta from Pulau Berhala.

(identified by Lieut.-Col. J. STEPHENSON)

*Pheretima indica* (HORST) f. *typica*  
 „ *berhalana* STEPHENSON  
*Perionyx violaceus* HORST  
*Pontoscolex corethrurus* (FR. MÜLL.)  
*Glyphidrilus horsti* STEPHENSON

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## NOTES ON THE LIST OF REPTILES OF JAVA

by

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On request of Dr. K. W. DAMMERMAN I revised and annotated a list of the reptiles from Java which was made after DE ROOIJ: Reptiles of the Indo-Australian Archipelago (Vol. I 1915, Vol. II 1917).

This list was published (Treubia Vol. XI) without the annotations and I think it advisable to give these notes here separately. At the same time I include the results of articles published since the revising.

If localities are given without further reference to literature they are taken from DE ROOIJ (op. cit.).

The nomenclature is also according to DE ROOIJ.

*Hemidactylus frenatus* DUM. et BIBR.

This species is recorded from East Java (Soerabaia) by MERTENS (1929). It was not yet mentioned from this part of the island.

*Hemidactylus garnoti* DUM. et BIBR.

Lesser Sunda Islands: Lombok, MERTENS (1927 p. 242).

*Mimetozone craspedotus* (MOCQ.)

Recorded from Java by HOLTZINGER (1920). At the time of revising the list this publication was not available to me. Thanks to the author's kindness I am able to make use of the original publication, and so some other species mentioned from Java which were not cited in the Zoological Record are included here. MERTENS (1929) had controlled the identification of the specimens mentioned by HOLTZINGER, and it was found that they were not *Mimetozone* at all but *Hemidactylus platyurus* (SCHN.).

*Gehyra mutilata* (WIEGM.)

Lesser Sunda Isles: Komodo, Wetar: DUNN (1927b); Bali, Lombok: MERTENS (1927, p. 242). Central Java was not mentioned in the list, MERTENS (1929a, p. 26) records specimens from Wonosobo and Borobodoer.

*Aphaniotis fusca* PTRS.

Recorded from Java by HOLTZINGER (1920, p. 101). MERTENS thinks that either the identification or the locality must be wrong (1929a, p. 26).



*Cophotis sumatranus* HUBR.

MERTENS (1921, p. 179-180; 1929a, p. 32) mentions a specimen from West Java.

*Gonyocephalus borneensis* (SCHLEG.)

Not mentioned in the list; HOLTZINGER (1920, p. 101), records a specimen from Java.

*Gonyocephalus chamaeleontinus* (LAUR.)

DUNN (1927b, p. 4) writes: "*G. kuhli* is clearly a synonym".

So far as one can judge from the small number of specimens at my disposal I can well agree with DUNN.

*Calotes versicolor* (DAUD.)

HOLTZINGER (1920, p. 101) mentions a specimen from Java.

MERTENS (1929a, p. 28) quite rightly doubts this locality. Up to this time the species was known in the Archipelago only from Sumatra (DE ROOIJ).

*Tiliqua gigas* (SCHN.)

Sumatra; WERNER, Zool. Jahrb. 28, 1910, p. 286.

Further eastern part of the Archipelago: Moluccas, Aru and Kei Isles, New Guinea.

*Mabuia rugifera* (STOL.)

Also on the Nicobars.

*Mabuia multifasciata* (KUHL)

*M. rudis* BLGR. is a synonym: SMITH: (1927, p. 215).

*Lygosoma*.

In the list I have taken the names as given by DE ROOIJ.

If we take the description of 13 specimens of *Lygosoma emigrans* (v. LIDTH) by DUNN (1927b, p. 6) it is clear that a division into separate genera or subgenera is not possible.

*Lygosoma smaragdinum* (LESS.)

MERTENS (1929 b, p. 213) writes: „auf Java fehlt *Dasia smaragdinum* bestimmt". The specimen mentioned by DE ROOIJ (I, p. 20; v. LIDTH 1893, p. 252) does not belong to this species (MERTENS 1929b, p. 215) so that possible it does not occur at all in Borneo.

*Lygosoma leucostictum* MÜLLER.

This species was described by MÜLLER (Zool. Anz. Bd. 57, 1923, p. 54) from Java?

*Lygosoma temmincki* DUM. et BIBR.

Lesser Sunda Isles: Bali, MERTENS (1927, p. 242.)



*Lygosoma cyanurum* (LESS.)

STERNFELD (1920, p. 407) and PARKER (1925, p. 299) came to the conclusion that the specimens mentioned by most authors under this name belong to two distinct species:

One with 33-51 subdigital lamellae occurring in the Archipelago from the New Hebrids and Solomon Islands westwards; the other with 65-80 lamellae from the Moluccas <sup>1)</sup> eastwards.

The species with the low number of lamellae was named *L. kordoanum* by STERNFELD, *L. lessonii* by PARKER.

According to SCHÜZ (1929, p. 7-9) the name must be *L. weneri* VOIGT 1912. The species with the high number of lamellae keeps the name *L. cyanurum* (LESS.).

Specimens from Borneo were examined by DUNN (1927b, p. 10) and found to belong to *L. weneri*. Specimens from Java were examined by me with the same result. It is possible that the occurrence on these islands is not a natural one. DE BEAUFORT (1926, p. 94) mentions a specimen seen running on the railing of a ship between Soerabaia and Semarang. The ship came from the Moluccas and New Guinea.

DUNN (1927b, p. 9) mentions the possibility that the specimens mentioned by DE ROOIJ (I, p. 254) from Samao, Timor and Groot Bastaard belong to his new species *L. similis*.

*Lygosoma actrocostatum* (LESS.)

Mentioned under Malay Peninsula; according to DE ROOIJ only Pulu Tiku near Penang and Singapore.

*Lygosoma bowringi* (GTHR.)

Lesser Sunda Isles; Bali, Lombok: MERTENS (1927, p. 242).

Sumatra (Atjeh, Lho Seumaweh): MERTENS (1929c).

*Lygosoma albopunctatum* GRAY.

Java, HOLTZINGER (1920, p. 102), not mentioned in the list; MERTENS (1929a, p. 26) doubts the locality.

*Typhlops polygrammicus* SCHL.

Lesser Sunda Isles: Timor.

*Tropidonotus subminiatus* SCHL.

Sumatra, WERNER: Misc. Zool. Sumatrana XIX, 1927, p. 1.

*Simotes signatus* GTHR.

Malay Peninsula: only Singapore.

*Ablabes libertatis* (BARB.)

This species is a synonym of *Zamensis korros* SCHL.: DUNN (1927a, p.1).

*Calamaria sumatrana* EDELING.

Malay Peninsula: only Singapore.

<sup>1)</sup> See also KOPSTEIN: Zool. Med. Leiden, Vol. 9, 1926, p. 95.



*Calamaria goeringi* VOGT.

This species was described from Java without an exact locality (Zool. Anz. Bd. 62, 1925, p. 65).

*Calamaria leucocephala* (DUM. et BIBR.) and *Calamaria agamensis* BLKR. Lesser Sunda Isles: Bali, MERTENS (1927, p. 242), as *C. agamensis*; *C. agamensis* is an individual variation of *C. leucocephala* (MERTENS, 1929c).

*Calamaria javanica* BLGR.

Borneo: *C. j. lineata* BRONGERSMA: Zool. Anz. Bd. 75, 1928, p. 256.

*Amblycephalus carinatus* BOIE.

MERTENS (1927, p. 242) records *A. carinatus* (WAGLER) from Lombok and from Java (1929a, p. 32). WAGLER must be used as author's name instead of BOIE (BARBOUR, Mem. Mus. Comp. Zool. Vol. 44, p. 138, 1912).

*Vipera russeli* (SHAW).

DE ROOIJ did not include this species in her work as she doubted its occurrence in the Archipelago.

BOULENGER (1896, p. 490) mentions the species from Java with a (?).

DUMÉRIL and BIBRON (1854, p. 1435) mention a specimen from Java.

STRAUCH (1869, p. 87) records a specimen from Sumatra (in the Leiden Museum).

DITMARS (1910, p. 323) records specimens from Sumatra.

In 1927 DUNN (1927a, p. 4) collected two specimens on Komodo and MERTENS (1927, p. 182) one specimen at Ende (Flores).

DUNN has compared his specimens with specimens collected in India and finds no difference.

MERTENS describes his specimen as a new subspecies *V. r. limitans*.

These discoveries make it more probable that the species occurs, and then very rarely, or occurred on Sumatra and Java.

*Notochelys platynota* (GRAY).

Mentioned by DE ROOIJ in the descriptive part (Vol. I, p. 304) but not in her list on p. 349.

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## CORAL REEF STUDIES.

### I. THE SYMBIOSIS BETWEEN DAMSELFISHES AND SEA ANEMONES IN BATAVIA BAY.

By

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#### INTRODUCTION.

It is a wellknown fact that in the fishfamily of the Pomacentridae, which counts so many representatives on the coral reefs of the Indo-Australian Archipelago, several species, all belonging to the closely allied genera *Amphiprion* and *Premnas*, live together with large sea-anemones, especially those of the genus *Stoichactis*. About the real nature of this association, however, very little is known and the propagation of these fishes has as little been studied as that of the other fishes inhabiting these wonderful reefs. The only paper dealing with the association in somewhat more detail is that of SLUTER, to which I shall refer more than once.

The observations given here were partly carried out on the coral reefs of Batavia Bay, especially on those in the Western half, round the islands of Onrust, Schiedam, Haarlem and Hoorn. For a large part, however, they were made in the Onrust Aquarium of the Laboratory for Marine Investigations. This aquarium, built in 1928, offers unique opportunities for studying the reef fauna; it is fed by water pumped up from above the reef, receives full sunlight, and the contents of the tanks are pieces of sea bottom themselves in which anemones, gastropods, fishes, etc., propagate as under natural circumstances. The observations covered a period of two years: part of 1928, 1929 and part of 1930.

My most hearty thanks in connection with this work are due to Mrs. and Mr. STEINFURTH, medical officer and administrator to the Quarantine Station Onrust-Kuiper, who not only made my stay on the island most agreeable, but also assisted largely in the work during the months of the investigations. I further wish to express my feelings of gratitude to the authorities of the Medical Service, Batavia, whose kindness made it possible for me to stay on this quarantine island during the periods in which the station was not used. I also hope to owe many thanks to Prof. FERDINAND PAX, Breslau, Germany <sup>1)</sup>, who kindly will identify the anemones for me and help me in understanding the

<sup>1)</sup> As I have not yet received the result of Prof. PAX' examination of the anemones I provisionally indicate the different species by figures. The names will follow in a special note.



synonymy of the species mentioned in literature. Lastly I thank Prof. DELSMAN and Dr. BOSCHMA for their remarks on the contents and redaction of this paper.

It will be seen from the chart that Onrust is lying close near the mangrove coast of Java, which grows seaward year by year, and for that reason is surrounded by water quite rich in silt. In fact, on windy days this water may be so muddy, that one cannot see the corals in water of one metre depth. The water round Haarlem, on the other hand, is much clearer, so that we find on that island several animal forms which are lacking at the Onrust reef: *Acanthaster echinites*, *Stichopus*, anemone 2 and 4, a green *Comatula*, and some others. For the sake of comparison I shall now and then refer to the reefs of Edam, Dapur and other islands. Of these Edam, though geographically it may be reckoned to belong to the Bay, in reality shows so many affinities to the Thousand Islands proper, that we feel justified in treating it as an island lying outside the Bay of Batavia. Dapur, a small island with a magnificent reef, lies about six miles north of Haarlem, quite outside the Bay and its rich reef may be mentioned as a typical example of a Thousand Islands reef. Its wealth of anemones is extraordinary.

After the work for this study had been finished, our laboratory bought, with other instruments, the diving helmet of the Netherlands Oceanographical Expedition to the Moluccas under the leadership of VAN RIEL (zoölogist Dr. H. BOSCHMA). This helmet, as was to be expected, brought to light much, we had not dreamt of. In connection with the work on damselfishes it is interesting that, whereas some animals, for instance anemone 2, *Amphiprion polymnus*, a green *Comatula*, enter the Western half of the Bay to Haarlem only, as far as the shallower water — up to 3 m at low tide — is concerned, these animals approach the coast nearer in deeper water, so that at Hoorn below 3 metres they are quite common. This confirms my remarks on page 309 (small type), where I say that the quantity of silt at one and the same reef decreases with increasing depth of the water. — I have tried to add these observations made with the diving helmet as far as possible. As, however, it was too late to alter too much, I wish to remark that a fairly large number of observations was available. At one and the same reef several clear water species can live or even thrive in deeper water when they cannot live nearer the surface there.

#### SHORT SUMMARY OF THE LIFE HISTORY OF THE SYMBIONTS.

The damselfishes occurring in the Bay of Batavia are: 1. *Premnas biaculeatus* (BLOCH), 2. *Amphiprion ephippium* (BLOCH), 3. *A. polymnus* (L.), *A. percula* (LACÉPÈDE), 5. *A. akallopisus* BLEEKER. The most distinctive feature these five species of damselfishes have in common is their close association with large sea-anemones which are very common on nearly all the reefs in the Bay of Batavia. These species are: anemones 1, 2, 3, 4, 5 and possibly 6.

Though the closeness of this association shows different degrees in the different species, we are perhaps always dealing with true symbiosis, using that



term in the original sense: both partners deriving advantages from their living together. But I return to this point furtheron. Before treating this subject in detail, I shall give a short summary of the life-history of fish and anemone. Hitherto the propagation of only three of the five species has been studied in detail by me, but they seem to resemble each other so closely in this respect, that all five probably may feel at home under this scheme.

In visiting the reefs and looking for large anemones <sup>1)</sup> one generally finds that each anemone, or each group of 2-3 anemones living close together, are inhabited by two fishes belonging to one of the five species mentioned. They dive into the wood of tentacles of the anemone, coming out again, snapping for food in the water round the place in question, in short, they distinctly show that they feel quite at home there. If one approaches them, they disappear among the tentacles, only to reappear every now and then, their heads popping out from between the tentacles and disappearing again. Some of them, however, especially if we are dealing with specimens of *Premnas biaculeatus* and *Amphiprion ephippium*, may swim at the intruder and bite his legs or shoes. With a small handnet they are easily caught then.

If one tries to loosen the anemones, in which one may succeed after great difficulty, the fishes (especially *A. percula* and the young ones of the other species) may lay down between the tentacles or on the oral disc and remain there even if the anemone is taken out of the water, probably sticking somewhat to the mucus of the anemone. Or they may (this often occurs in the larger species) bite one's hands or flee for fear and swim hither and thither, returning again and again to the spot in question. They never enter the gastric cavity, however, as is stated in many handbooks.

Transferred to the aquarium, the fishes do quite well without their anemone, though, especially with the large *Premnas*, it may take a very long time before they are accustomed to these unnatural circumstances. As soon, however, as they are brought together with fishes of prey, even small specimens of *Lutianus*, *Epinephelus*, etc., they are caught one after the other, as they move slowly and do not hide. Brought into the sea without anemones they are quite helpless. From this we see that the anemones protect these fishes from enemies. A further point of interest is that the fishes feed directly and indirectly on the anemone. The latter is partly their source of food.

The anemones brought into the aquarium may live without the fishes. But most of them appear to thrive somewhat better when the fishes are there, without the latter they seem to have somewhat less resistance to unfavorable circumstances. The resistance of the different species seems to be different in this respect, the long stalked anemones of *Premnas* and *A. ephippium* probably being

<sup>1)</sup> In this work a so-called sea-glass is used, consisting of a somewhat tapering cylindrical wide tube of a diameter of 25 cm below, made of zink, closed by a piece of thick window-pane. It is put on (a little in) the water so that the surface of the latter below the glass is smooth and permits a view of the sea below.



the most sensitive ones; anemone 1 and 3, on the contrary, even resist bad circumstances and may be found without fishes in nature, if they are living in places where the fishes do not occur. The reason for this pining away of the anemones is to be found in the behaviour of the fishes. An anemone which is sickly and does not expand is treated by the fishes in a very characteristic way: they swim above the anthozoön, waving their large pectoral fins and trying to open their host by diving into and rubbing against it. Moreover, as I shall explain later on, the anemone fishes may feed their anemones. So the anemones are probably more or less dependent on the fishes as they are fed and oxygenated by them. All this has been observed by SLUITER in 1888 already.

The two fishes inhabiting the anemone are, normally, male and female. As they never leave the anemone, propagation must take place in its vicinity. In this respect *Amphiprion percula* is now known best. The eggs, which are of considerable size, are fastened in small numbers to the wall of the aquarium (coral rock) near the foot of the anemone. In *percula* they hatch after seven days, during which time the parents, especially the male, protect them carefully. The young fishes swim to the surface of the water, where they feed on plankton. After a certain time, when they have got an orange tinge and a small white collar, they go down to the bottom where they search for anemones. It is possible that these young ones, finding anemones already inhabited by damselfishes (of the same or another species), are sometimes eaten by the latter as long as they are very small; I have, however, no direct evidence for this opinion and some of my observations seem to point to the contrary. In growing they become too large to be eaten and are driven out then by the older animals. In the case of *A. percula*, however, which is very small and may live in very large anemones, one may find up to seven or more fishes of different sizes in one and the same anemone. The same may occur in *A. akallopisus* and (to a lesser extent) in *polymnus*. Especially in the larger species, *Premnas* and *A. ephippium*, we never find more than two animals, male and female, together, as all other animals above a certain size are very fiercely driven out.

Summarizing we see in the first place that the association between damselfish and anemone is probably one of the most ideal examples of true symbiosis one can imagine. And further that the small number of eggs is protected by the parents, that the young ones swim to the surface where they are preyed upon to serve other animals as food, then return to the bottom in search of anemones, finally partly depend on the welfare of the species for their remaining alive or not. It may be observed here that the planktonic life of the newly hatched animals must be of great value to the species, as this is probably the only way in which new reefs may be populated.

After this short general summary of the life-history we now may treat the association more in detail. I wish to observe once more, however, that SLUITER, in his nice description of the association here treated, for *Amphiprion percula* and *polymnus* gave several details in 1888 already, and that all this conclusions



as to the „value” of the association were the same as those given above. As I read SLUITER's paper only after having written this article, there seems to be some chance that our conclusions may be more or less right.

#### THE BEHAVIOUR OF THE ANEMONES.

The anemones with which the damselfishes live together are anemones 1, 2, 3, 4, 5, and possibly 6. As the ecological conditions which govern the distribution of the damselfishes on the reefs depend for a good deal on the ecological demands and consequently on the distribution of the anemones I first give a short summary of the gross ecological wants of the anemones.

##### *Anemone 1.*

This species occurs very commonly round all the islands of Batavia Bay, especially near those which have shallow lagoons. It is by far the most hardy one of the five species mentioned and it occurs in places, e.g., shallow parts of small lagoons, where no other anemones and only very few corals stand the bad conditions: much silt, much variation in temperature, high temperature, little oxygen during the night, etc. In fact, it seems that one of the principal demands of this species is: water rich in silt.

The quantity of silt in the Bay of Batavia decreases with increasing depth of the water. It has been measured by a rather inaccurate method, viz., by measuring the depth at which SECCHI's disc disappears to the eye (VERWEY, 1930a). From these measurements it follows that the quantity of silt on the Onrust reef, which is lying close to the mangrove coast in a sea of little depth, causes the disc visibility to be about 4 metres, whereas for Haarlem it may be at its least 8 metres. So we may perhaps assume that the quantity of silt near Onrust is about twice that of the water near Haarlem.

But, moreover, the quantity of silt on one and the same reef decreases with increasing depth. I have only one series of exact observations in this connection, which I owe to the kindness of ir. MARKUS, then chemist at our laboratory. On July 12th, 1928, I took three water samples on three different places of the Hoorn Reef: 1. in a small, very shallow part of the lagoon, 2. in a deeper part of the lagoon, 3. outside the shingle wall in the surf. The depth of these places was for 1. about 30 cm, water smooth, for 2. about 100 cm, water less smooth, for 3. about 150 cm, surf. The following values were found in mg per liter:

Time	1	2	3
11 a. m.	198	40	87
2 p. m.	305	87	214
4 p. m.	107	63	71

The values at 2 p.m. are highest on account of the strong wind then prevailing. Though the water in the shallow part of the lagoon is smooth and in any case much



less agitated than that of the two other places it shows the largest quantity of "silt" (especially sand) of the three places in question because of its shallowness. Place 2, with little agitated water of somewhat greater depth, and place 3, with surf and still greater depth, both show lower figures than place 1 (see postscript, p. 353).

Generally this species occurs in sandy places where the water is undisturbed and shallow. As already remarked it occurs even in very shallow parts of the lagoon or on the inside of the shingle wall where the surface is exposed during very low tides and it endures there being exposed to the sun for some hours at a time. Consequently the depth to which this species descends is rarely more than half a metre at low tide. At Onrust, however, very large specimens, inhabited by up to seven orange damselfishes, are to be found in water up to 2 m deep at very low tides; I know of no other place in the Bay of Batavia where this is the case. The reason for this occurrence in greater depth (3 m during high tide against 1 to 1.5 m in other places) may perhaps be found in the preference of this species for a large quantity of silt. On the reefs somewhat farther from the coast this quantity of silt is perhaps large enough in shallow places only, on the Onrust reef, however, the quantity of silt is so large that even at a greater depth it may be sufficient for this anemone. Not only does this anemone stand a large quantity of silt, it even does not starve when from time to time halfway buried under the sand. From these observations it follows that on the reef itself where we find a luxuriant growth of coral, greater depth, little sand and silt, this species is little or not at home.

Anemone 1 sticks to objects with which it comes into contact much more strongly than the other species of anemones here dealt with. If one puts his hand or a stick between the tentacles, and takes it back again, the tentacles adhere strongly and are torn off from the anemone. The tentacles themselves, which are small and very numerous, are of a greyish- or brownishwhite or light pink colour. The columnwall shows the same or a beautiful light blue colour, with longitudinal rows of orangeyellow to violet spots, which are not distinct. Though the normal colour of this species is greyish or brownish white, one sometimes finds clear green, blue or violet blue specimens and even such, which are of a beautiful, very dark blue. I know such specimens from very shallow places in the lagoon only, especially from Hoorn. Anemone 1 may reach a size of half a metre when fully expanded.

This species is solely inhabited by *Amphiprion percula*. Where it occurs in very shallow places in the lagoon, however, this fish does not remain in it during periods of low tides, as there is not enough water for it. That is the reason why anemone 1 in such places is often found without its fish. There are even places where the species is probably never visited by damselfishes, and where, notwithstanding this, it thrives quite or rather well.

In the Onrust Aquarium this species was also accepted by *Amphiprion akallopisus*, though a number of specimens of anemone 4 were present in the same tank. In the public aquarium at Batavia it was without delay accepted by two *Amphiprion polymnus*, with which it was brought together.



SLUITER, in his paper of 1888, seems to refer to anemone 4, as being the only species inhabited by *Amphiprion percula*. But he apparently believed anemones 1 and 4 to be one and the same species. See below.

#### *Anemone 2.*

Anemone 2 is rather rare on the reefs in Batavia Bay. In shallower water (up to 3 metres at low tide) I only found it on the Haarlem reef, where it prefers somewhat deeper water than anemone 1, with coral growth and without sand. Doubtless the reason for its occurrence at Haarlem only (in so far as shallower water is concerned) is to be found in its need of clearer water, for I found it in the same way at Edam and Dapur; and since our Laboratory possesses a diving helmet I found it (in deeper water) on some reefs closer to the coast, e.g. Hoorn. For the same reason it never inhabits lagoons. This anemone, when young, resembles anemone 1, but, especially in deeper water, it grows to a much larger size (one, perhaps even one and a half metre in diameter), sticks less and is of a greyish or greenish brown colour, which is darker than that of anemone 1. Moreover, the longitudinal rows of spots on the columnwall are more distinct than in the latter species, and the tentacles are longer and somewhat broadened at their tips. As already stated, I found it between and on corals or coralrock only, down to a depth of about six metres or more.

I found this species always inhabited by *Amphiprion polymnus*, which has a strong preference for it. Only once — 24 May 1930, Haarlem — I found it inhabited by *Amphiprion ephippium* (two old and two young specimens).

#### *Anemone 3.*

This very characteristic anemone, which sticks little, is colourless (whitish) with the exception of the tips of the tentacles which are nearly always distinctly violet. Young specimens may be violet all over their surface. The white colour would induce one to believe that zoöxanthellae, which are of so regular an occurrence in the Coelenterate inhabitants of the East-Indian reefs, are absent in this species; in general, pigmented forms look brown, as a result of their large number of yellow zoöxanthellae. This, however, is not the case; there are large numbers of zoöxanthellae, just as in the other species dealt with; but the thickness of the ectoderm, its little transparency, seems to be the cause of this phenomenon.

Anemone 3 occurs in water of 0.5 to 7 or more metres deep. Though it never inhabits lagoons, it shows some preference for somewhat open sandy places between huge colonies of *Porites* or between bushes of *Acropora*. There it may be anchored deep in the sand, so that its high columnwall (stalk) is partly buried under the sand and the large crest of long, pointed tentacles covers the bottom as a big white flower. Its most ideal habitat, however, seem to be the patches of reef, covered with dead corals, with a firm bottom of



coalesced coral, quite open, exposed to the sun, without much living coral bringing darkness. On the island Klein Kombuis, west of the Bay of Batavia, the species occurs so abundantly on such a part of the reef, south of the island, that one may count more than 20 of them in close vicinity of each other, all of them inhabited by *Amphiprion ephippium*. From all this we may conclude that anemone 3 is somewhat like 1 in its ecological needs, but cannot stand such unfavourable conditions as the latter. It inhabits muddy as well as clear water, being common at Onrust, Haarlem, Edam and on other reefs.

On the reefs studied by me this anemone is inhabited by two species of damselfishes, viz., *Amphiprion polymnus* and (especially young) individuals of *Amphiprion ephippium*. *Amphiprion polymnus* on my reefs is a rather rare damselfish, which occurs especially in somewhat deeper water. I found it living in anemone 3 a few times only. *A. polymnus* was not found by me at Onrust and neighbouring reefs (probably on account of the large percentage of silt) and consequently on these reefs anemone 3 is inhabited by *Amphiprion ephippium* only. As, however, the latter does not like quite open, sandy places, the anemones living in such places must do without a fish. In the public aquarium at Batavia anemone 3 was accepted by a young specimen of *A. akallopisus*, which is living in it together with a young *A. polymnus* now!

In the same way as the individuals of *Amphiprion polymnus* show a distinct preference for anemone 2 and may be found in 3 more exceptionally, mature *A. ephippium* show a distinct preference for anemone 5 and are to be found in 3 only when 5 fails. This seems to be the reason, that I rarely found, in the Bay of Batavia proper (viz., at Haarlem), adult *ephippium* in 3. But on the island of Dapur I found some few individuals and on the reef of the island Klein Kombuis many of them living in 3; on the reef of the southern side of the latter island, indeed, where 3 is very common and 5 scarce, all specimens of 3 are inhabited by *ephippium*, most of them by old ones.

It is worth mentioning that in *A. ephippium* we are dealing with a species, the young of which show a preference different from that of their parents. For whereas I found so rarely a d u l t *ephippium* associated with anemone 3 on the reefs in the Bay, y o u n g *ephippium* nearly always inhabit 3. Only twice (on the Dapur reef and at Haarlem) did I find a young in anemone 5. It may be, however, that this preference is only apparent; the number of anemone 5 is smaller than the number of couples of *A. ephippium* and *Premnas biaculeatus* and thus young *ephippium* may have to content themselves with anemone 3.

SLUITER's description of the anemone of *Amphiprion polymnus*, called by him *Bunodes*, seems to refer to this species. He says: "Die Grösse der See-Rose stimmt ungefähr mit der der vorigen Art überein, die Tentakel werden aber beträchtlich länger, bis 7 cm. Die Enden derselben tragen wieder eine violette Spitze. Der breite Fuss ist bläulich grau mit regelmässig angeordneten violett gefärbten Warzen. Die Scheibe und Tentakel sind sonst hell violett". This description holds partly good for anemone 3; it does not apply to 2, which is also inhabited by *polymnus*.



*Anemone 4.*

This anemone, which sticks very little, shows an extensive variation in colour. Its large broad tentacles may be greenishbrown or violetbrown, with yellowish or yellowishgreen tips; they may be brown to browngrey with whitish tips, or greybrown with purplish tips. The columnwall, which consists of a short column, is sometimes of a beautiful violet, sometimes, however, light yellowishbrownish. All these varieties are due to pigmentation of the ectoderm; they all show large numbers of zoöxanthellae in their entoderm. — The species fails round Onrust, occurs in small numbers round Schiedam, is very common round Haarlem and quite numerous on the fine reef of Pulu Dapur. At Hoorn it is rather common in deeper water. From this statement one may conclude that it needs clear water, without silt. Nevertheless it thrives quite well in the Onrust Aquarium where I kept some specimens, which are still alive, for nearly two years.

These anemones occur from very shallow water down to a depth of 8 metres or more (at Haarlem). Wherever they occur, one usually finds a number of individuals growing close together, sometimes so close, that they seem to cover old coralrocks with a carpet of long waving grass. This is a very striking peculiarity of this species. — *Anemone 4* occurs neither in the lagoons nor on sandy places, its substrate being coralrock or a bottom of coralfragments. It shows a distinct preference for settling on dead rocks of *Porites* with their smooth surface. The species does not need the crevices and holes, which *anemone 5* asks for, on the contrary, it loves full sunlight and may be found to react promptly on a decrease in the quantity of light on days with an overcast sky.

*Anemone 4* is inhabited especially by *Amphiprion percula*, further by *A. akallopisus*, which, however, in the Bay of Batavia is rather rare. Where *anemone 4* does not occur, as near Onrust, *Amphiprion percula* lives in 1; where 1 does not occur or is uncommon, as near Schiedam, *percula* inhabits 4. Where, however, both species occur together, *percula* inhabits the one as well as the other, apparently showing little preference for either. When, however, 1 also inhabits very shallow places, where 4 fails, the damselfishes are relatively more numerous in the latter, but only because they cannot live in such shallow water. During periods of high tides some of these anemones are inhabited by damselfishes, to be left alone again during periods of low tides.

In the Onrust Aquarium this species was also accepted by *Amphiprion ephippium*.

SLUITER's description of the anemone of *Amphiprion percula* surely refers to this species. He writes: "Auf den untiefen, bei Ebbe fast trocken fallenden Korallenriffen einiger kleinen Inseln in der Bai von Batavia, und zwar speziell auf den Inseln "Enkhuizen" und "Leiden", ist eine grosse *Actinia* sehr gemein, welche mit ihrem breiten glatten, hell lilafarbigem Fusse auf toten Korallenstücken festsetzt. Der Unterrand des Fusses (der Lembo von A. ANDRES, Le Attinie, IX. Monographie, Fauna und Flora des Golfes von Neapel) wird bis 2 dm breit. Die sehr zahlreichen



Tentakel sind etwa 2 cm lang und ziemlich hell gelblich violett gefärbt. Die Spitze eines jeden Tentakels ist ziemlich dunkel violett. Für gewöhnlich ist der Fuss niedrig, er kann sich aber zuweilen auch beträchtlich in die Länge ausziehen".

Though the length of the tentacles, when expanded, is up to 7 or 8 cm in this species, the lilac colour of the columnwall holds good for anemone 4 only. — A year before SLUITER sent his paper to Holland, however, during a session of the Koninkl. Natuurk. Vereen. at Batavia, on January 13th, 1887, he gave a lecture on some new and less known cases of adaptation and association of some animals and plants from the coast of Java. In this lecture, which was published in 1887, SLUITER also dealt with *Amphiprion percula* and its anemone and writes (I translate in English): "This animal is with the broad, fleshy, lightbluish-gray coloured foot attached to the shallow, during low tide up drying coast of the coral islands and between dead corallfragments. Numerous tentacles of 2 cm are to be found in many rows round the mouth. These tentacles are coloured darker or lighter violet". A lightbluish-gray coloured columnwall is typical for anemone 1 and does — as far as I know — not occur in any of the other anemones here treated. It follows from this that SLUITER first described anemone 1, that afterwards he believed that 4 and 1 belonged to one and the same species and then in his final description mentioned as characteristics of this anemone the purple columnwall (of 4) and the short tentacles (of 1). — On the islands Leiden and Enkhuizen, especially mentioned by SLUITER, we find anemones 1 and 4 together occurring in the same places, both inhabited by *percula*.

#### *Anemone 5.*

This beautiful anemone <sup>1)</sup> reaches a height of more than half a metre whereas the upper surface, when fully expanded, may have a diameter of somewhat more. If, however, one touches it, it contracts to a height of 5 cm and a diameter of perhaps 10 cm. By this peculiarity anemone 5 is very well "adapted" to its surroundings. Its habitat are the deep crevices and holes between and in the large colonies of *Porites*, *Maeandra* and other corals. There it is attached to the irregular bottom of the hole in such a way that it is hardly possible to detach it. Its long stalk stands erect and brings the oral disc to the niveau of the opening of the hole, which is filled up by the tentacles. Reacting on stimulation from outside it withdraws within the hole, down to the bottom. The columnwall is never exposed to sunlight. If the anemone occurs in a place which is insufficiently dark, the high stalk always remains contracted and the anemone seems to be in a more or less poor condition. — In the Bay of Batavia sensu stricto I do not know many places where this anemone occurs, because the surroundings: high coralrocks, with crevices, are mostly lacking. It is very common on Onrust, where, indeed, nearly all observations on this species were made, whereas I do not know it from Schiedam and found it in some specimens only on Hoorn and Haarlem. If we do not restrict ourselves to the reefs of the Bay proper, however, we find anemone 5 very common at Edam and Dapur. Whereas anemones 2 and 4 are more numerous as the water is clearer, 5 (just as 3) is not particular about there being much or little silt, but seems to ask only for its special surroundings, being numerous where there are crevices, deep holes, old coralrocks, etc. At Onrust, on a certain part of the

<sup>1)</sup> See also under "Anemone 6".



reef, east of the island, the species is so common, that one finds tens of them in and between the large *Astraeid* and *Poritid* corals in the deeper water. All of them are inhabited by fishes. Their stalk (columnwall) may be white or pink to brownish pink. The long tentacles are brownish green, the brownish colour, being due to *zoöxanthellae*, predominating when the anemone expands, the greenish one, due to pigment, especially appearing on contraction. A remarkable phenomenon in this species is the behaviour of the tips of the tentacles. They sometimes inflate so that they resemble a nipple, the broadest part of which, forming a distinct ring, being colourless in that case. As a strongly variable percentage of the tentacles may do this, one finds anemones with all or many of their tentacles inflated, others with nearly all of them pointed.

The fishes inhabiting this anemone are *Premnas biaculeatus* and *Amphiprion ephippium*. On the reef east of Onrust, just mentioned, the number of *Premnas* and *A. ephippium*, which on the whole are not very common, is so large that about 15 pairs of *Premnas* and approximately 6 pairs of *Amphiprion ephippium* are living in close proximity. Especially *Premnas* is a typical inhabitant of this anemone <sup>1)</sup>. Whereas except *Premnas* and *Amphiprion ephippium* (and *polymnus* in the aquarium) no other damselfishes ever inhabit anemone 5, *Premnas* does not inhabit any other anemone than this (and No. 6) (see, however, note on page 319). As already said, the same does not hold good for *Amphiprion ephippium*, because the latter also inhabits anemone 3, rarely 2, and in the aquarium 4.

DE CRESPIGNY's description of the anemone of *Premnas biaculeatus*, called by him *Actinia crassicornis* and found at the island Labuan in the China Sea, perhaps refers to this species. He describes how the tentacles, after a *Premnas* has passed over them, "immediately become erect and diverge as if galvanized, while their extremities become clubby and phosphorescent". As already stated the swelling of the tips of the tentacles is typical for this species. From the further description I am inclined to conclude, however, that he is dealing with more than one species in his description.

#### *Anemone 6?*

Of longstalked anemones which inhabit deep dark crevices or holes there occur perhaps two species in the Bay of Batavia. In that case the first, which was treated above, anemone 5, is perhaps the most common; it has very thick tentacles, which can inflate their tips, and the tentacles are of one colour (a greenish brown) all over their surface. The second, which is very similar to the first in appearance, has the same gross ecological wants, and differs from the first in the size and colour of the tentacles. The latter are somewhat longer, less broad (thinner) and more pointed than those of anemone 5, whereas their tips

<sup>1)</sup> The statement to be found here and there (e.g. HESSE-DOFLEIN, Vol. 2, p. 276), that only young *Premnas* inhabit these anemones, as old *Premnas* are too big for them, surely refers to WEBER's remark on this species in the *Fishes of the Siboga*, p. 334: „Es ist nicht anzunehmen, dass solche grossen Fische bei drohender Gefahr noch ihre Zuflucht nehmen könnten in Aktinien". Old as well as young *Premnas*, like all the other damselfishes, are never to be found without their anemone.



are always whitish and rarely inflate. The colour of the columnwall of this anemone is light pink. I am not quite sure, however, that both forms are not extremes of one and the same species.

I have already remarked that anemone 6 inhabits the same places as 5. In fact both forms may occur in close vicinity of each other, so that one pair of *Premnas* may inhabit 5 as well as 6. All that has been said about 5 applies in the same way to 6.

In the aquarium *Amphiprion polymnus* accepted anemone 6, although it possessed its own anemone (anemone 3).

Recapitulating the points of interest we saw that each of these species of sea-anemones shows a quite distinct preference for special surroundings. Anemone 1 occurs in shallow water only (especially in lagoons), be it muddy or not; it withstands very bad conditions, in fact seems to need them. Anemone 2, its nearest relative, wants clear water and goes down to greater depths, whereas it never inhabits sandy places, but always lives between corals. Anemone 3, though it stands rather unfavourable circumstances and likes open places, never inhabits lagoons and goes down to a much greater depth than no. 1. Its ideal habitat is to be found on the rather steeply sloping southern edge of the reef, where there is an abundance of dead and broken corals. Anemone 4 needs clear water and coralgrowth and goes down to considerable depth. Anemone 5, finally, loves holes and crevices, where it can hide its long columnwall and in which it can contract during the night.

As regards the general lifehistory of these five species of anemones it may be remarked that they are diurnal, as they expand from sunrise to sunset and retract from sunset till the following morning. It seems to be well known (vide PAX) that this diurnal habit is especially found in species which contain zoöxanthellae. The five species here mentioned indeed harbour large numbers of these algae. — One has to bear in mind, however, that, whereas nearly all reef corals have zoöxanthellae (cf. BOSCHMA, 1923), many of them are nocturnal and retract during the day.

The zoöxanthellae of these anemones measure up to 30-35  $\mu$  in diameter. They occur in large numbers in those specimens of the five species I studied and give them a brown colour, corresponding with that prevailing on a coral reef. The colour varieties of anemones are due, as is well known, to true pigment and not to different quantities of zoöxanthellae. Only in one instance did I find a typical colourpattern due to the occurrence of zoöxanthellae. A green brown specimen of anemone 1 showed broad marginal stripes of a distinct yellow colour. Examination of this anemone proved that the yellow as well as the greenbrown tentacles were showing a yellow pigment, but whereas the greenbrown tentacles contained numerous zoöxanthellae, the yellow ones were devoid of any algae. After having lived in the aquarium for some time the anemone became greyish brown all over its surface.

With regard to the reproduction of these five species of anemones I can only say that\* during the second half of April, 1929, large numbers of young anemones,



many hundreds, appeared in one of the tanks (no. 4) of the Onrust Aquarium. They probably prove that the anemone, which produced them, is viviparous. As no anemones appeared during that time in the other tanks, they must have been produced by the anemones living in the tank itself. The tank contained one specimen of anemone 4 and two specimens of 5. I do not know whether these anemones are hermaphrodite or dioecious, and if hermaphrodite, whether self-fertilization may occur or not (vide STEPHENSON, 1929). So I do not know to which of the two species these young belong. In the spring of 1930 most of them had died (from lack of food I suppose), but others grew rapidly, the largest having reached a diameter of 10 cm or more in September 1930. From this it may follow that these species probably need several years for reaching their definite size. Again, during the second half of May or the first half of June large numbers appeared in another tank, in which only one specimen of anemone 5 and one of 3 lived. However, as I am not quite convinced of the impossibility of their having been introduced into this tank from the other one (with water by means of a syphon), I do not attach much value to this find.

These young anemones are very active. PAX remarks: "Die Fähigkeit des Schwimmens besitzen ausser den Aktinienlarven, deren Cilienkleid eine lokomotorische Funktion hat, nur wenige erwachsene Formen. Bei *Gonactinia prolifera* erfolgt das Schwimmen in der Weise, dass alle Tentakel rhythmisch nach rückwärts geschlagen werden. Durch den Rückstoss wird der Körper nach vorn getrieben. Über Schwimmbewegungen der planktonisch lebenden Myniadiden ist nichts bekannt". In the same way, as described for *Gonactinia*, these young anemones, even up to a year old, swim by rhythmical movements of the tentacles. By these movements they are able to reach conditions wanted by them; if they settle down on sandy or muddy spots, they rise again and by feeble swimming movements and the motion of the water, they get a chance to find a better place. Dr. HARDENBERG, fellowzoölogist at our laboratory, encountered large numbers of another young swimming sea anemone on January, 7, 1928, when fishing in Sebangka Strait, Lingga Archipelago (0°13' N., 104°25' E.). They moved with the water which was flowing 5 miles an hour. Large numbers attached themselves to the ship's anchor cable. The nearest reef was lying about one to two miles away. — Not only do these anemones swim, when very young they also move rather fast over a firm background by muscular contraction of their footsole, being attached to it loosely only.

It is noteworthy that these young anemones appeared during the beginning of the east monsoon, the turn of the weather during the northern spring, about the hottest time of the year (VAN WEEL, p. 8-10). This time also is the chief breeding period for the birds of West Java (vide SODY, below, p. 339).

#### THE BEHAVIOUR OF THE FISHES.

The damselfishes occurring in the Bay of Batavia are *Premnas biaculeatus* (BLOCH) and four species of *Amphiprion*, viz., *percula* (LACÉPÈDE), *akallopisus*



BLEEKER, *ephippium* (BLOCH), and *polymnus* (L.)<sup>1)</sup>. Of these five species *percula* is by far the most common, in some places, e.g. on Haarlem, being quite numerous. *Premnas biaculeatus* and *Amphiprion ephippium* are both far less common, though they can by no means be called rare. They are more exacting than *Amphiprion percula* but do not fail where they find suitable conditions. *Amphiprion polymnus* is rather rare on the reefs in Batavia Bay. I found it at the reefs of Haarlem and Enkhuizen, but in deeper water it is not uncommon at Hoorn and other reefs. It also occurs round Edam and Dapur, but I did not find it in the neighbourhood of Onrust, presumably because it needs clearer water. *Amphiprion akallopis* finally is decidedly rare in the Bay, I found it at Schiedam (once), Haarlem (twice) and Edam. As it is quite common on the fine reef of Dapur, where here and there up to seven specimens inhabit one single group of anemone 4, we may conclude that it needs clear water and that the sea closer to the coast is too muddy for it.

As to the general life-history of these species it be remarked here only that they are never found without their respective anemones and that — like the latter — they are diurnal, going to sleep between the tentacles or folds of the oral disc of the anemone during the night. This, at least, holds for *Amphiprion percula*.

For the sake of clearness, we may now treat the different points of the life-history of the fishes under different heads.

#### 1. The preference of the fishes for distinct species of anemones.

In the preceding pages we have seen that the different species of damselfishes have a marked preference for special anemones. The largest of them, *Premnas biaculeatus*, exclusively inhabits the large anemone 5, with its long tentacles (see, however, note on page 319). The smaller *Amphiprion ephippium* also inhabits 5, but (especially when young) it inhabits also 3, I found it once in 2 and in the aquarium it accepted 4. *Amphiprion polymnus* inhabits especially anemone 2 (with rather short tentacles), more rarely 3 (with very long tentacles), whereas in the aquarium it also accepted 5 and 1. Of the two smallest species, *Amphiprion percula* and *A. akallopis*, I found the latter together with anemone 4 only (in the aquarium it accepted 1 and 3), whereas *percula*, the commonest damselfish of the reefs in Batavia Bay, inhabits 1 and 4.

I already referred to SLUITER's paper, which also deals with the fishes from Batavia Bay.

KENT, in his work on the Great Barrier Reef of Australia, gives some further cases of distinct preference of damselfishes for definite species of anemones. So, according to him, *Amphiprion percula* inhabits always *Stoichactis kenti* (HADDON)<sup>2)</sup>, *Amphiprion bicinctus* (*polymnus*) is always to be found in *Stoichac-*

<sup>1)</sup> For colour descriptions of these species and their colour change during growth see the Appendix to this paper in the same number of this volume.

<sup>2)</sup> According to WHITLEY (1929, p. 215) KENT mentions *percula* as living together with *Stoichactis kenti* and *S. haddoni*. This is a misreading of WHITLEY, however.



*tis haddoni* KENT. "In Western Australian waters (The Naturalist in Australia, 1897, p. 219), where he also met with the above-named Anemones, he found *D. Kenti* accompanied by another *Amphiprion*-species, that had the orange ground-colour of the body of *A. percula* and *bicinctus* (= *polymnus*) substituted by a scarlet or black hue as in *A. Clarkii*" (HORST, 1903). I suppose that this third species also may have been *polymnus*, which shows a wide variation in colour.

One may ask why these different species of fishes show such a pronounced preference for special anemones as their host. On the small reef, east of Onrust, anemones 1, 3 and 5 occur together. Although up to seven or eight *A. percula* inhabit one single specimen of anemone 1, this fish is never found in 5 or in 3, though round Onrust the habitat of the latter is about the same as that of 1 and several animals of this species are not inhabited by a fish; and although *Premnas* is very common there, it never inhabits one of the other anemones and remains solely restricted to 5.

Doubtless the ecological conditions, wanted by anemone 1, do not correspond to the wants of *Premnas*, and it is the same with the other cases. That, however, these conditions do not govern the choice of the fishes, follows from the fact that *Premnas*, brought into an aquariumbasin with different anemones, which all live under quite the same conditions, does not care for them except when anemone 5 is present. <sup>1)</sup>

On December 2, 1929, I made the following experiment. Tank no. 6 of the Onrust Aquarium contained 7 anemone 4 of different colours and sizes, 3 anemone 2, 4 anemone 1, 1 anemone 5. In this tank I placed a large female *Premnas*, which did not appear quite healthy. It remained in the corner of the basin, without showing any interest in the specimens of anemones 1 and 4 in its close proximity. I then after some time put into the same basin a small male *Premnas*. This male had lived for some time with the female together in an aquariumbasin at Batavia. The male remained with the female, in the corner of the basin; it showed no interest in the anemones just mentioned, which after a short visit were left again. I then placed a second male in the tank, with quite the same result. I now removed the female, so that the males began to move through the tank. Especially the first male swam to and fro, it visited all the anemones, without, however, showing any further interest in them. At last it came in the neighbourhood of anemone 5, which was completely contracted, whereas the other anemones were in a much more expanded condition. At first sight anemone 5 resembled a small specimen of 4, even the tentacles, being contracted, looking not unlike those of that species. Nevertheless *Premnas* at once recognized the anemone as its own species, it first hovered over it, just as with the other anemones, then dived between the tentacles and did not leave it. It seemed probable to me that optical stimuli gave the first reaction, after which chemical stimuli settled the question. — The second male after some time also found this anemone. But the first drove it away and though there were so many other anemones at its disposal, the second male continued moving to and fro, without accepting one of these other anemones.

<sup>1)</sup> I may add at once that a small specimen of *Premnas biaculeatus*, brought from the reef of Hoorn on November, 23, 1928, in the end of December, 1928, accepted a specimen of anemone 4, with which it had lived in the same tank for more than a month.



In an earlier experiment, on December 1, I had brought the same female *Premnas* in one of the other tanks, in which besides one specimen of anemone 3, fully expanded, was a specimen of 5, quite contracted. Brought into the tank the fish swam right down to the latter. So it must have recognized the anemone from its general appearance alone.

I first thought that gross morphological differences between the anemones caused the remarkable preference of the fishes for a certain species. There is a superficial correlation between the size of the fish and the size of the tentacles of its host.

Name of fish	Maximal size of fish in cm.	Name of anemone inhabited by the fish in question	Maximal size of tentacles in cm.
<i>Amphiprion percula</i>	8.-	anemone 1	1— 2
		„ 4	7— 8
<i>Amphiprion akallopisus</i>	9.5	„ 4	7— 8
<i>Amphiprion polymnus</i>	13.6	„ 2	1— 2 <sup>1)</sup>
		„ 3	15
<i>Amphiprion ephippium</i>	12.-	„ 3	15
		„ 5	7—10
<i>Premnas biaculeatus</i>	16	„ 5	7—10

We may also put it in another way and say: anemone 1, with very short tentacles (1-2 cm), is only inhabited by *Amphiprion percula*, no. 4, with longer tentacles (7-8 cm), by *percula* and *akallopisus*, number 3 with very long tentacles (15 cm) by *A. ephippium* and *A. polymnus*, whereas anemone 5, with long tentacles (7-10 cm), is inhabited by *A. ephippium* and *Premnas biaculeatus*. Though there may be some truth in this statement, closer examination tells us that the statement as such does not hold. For a small fish like *percula* inhabits anemone 1, whereas the much larger *polymnus* inhabits the closely related 2. The large *Premnas biaculeatus* inhabits 5, the tentacles of which are shorter than those of 3, which is inhabited by the smaller *A. polymnus* and *ephippium*. Moreover it would be difficult to understand why a small fish like *percula* besides anemone 1 also inhabits no. 4, with tentacles so quite different from those of the former.

The preference of the fishes for distinct anemones is, however, much better "understood", if we not only take into account the size of the tentacles, but if we pay attention to the total size of the anemone and the size of the tentacles combined and then, moreover, compare the ecological wants of the anemones with those of the fishes. — The large *Premnas biaculeatus* prefers a very

<sup>1)</sup> The large specimens of anemone 2 in deeper water have longer tentacles.



large anemone with long tentacles, which is able to hide the fish by its size. *Premnas* shows, however, also a strong preference for holes, dark places between coral rock, etc. Among the large anemones there is but one species with these requirements: anemone 5, which never exposes its columnwall of half a metre long, but hides the latter in deep holes. We can understand that no other anemone fits *Premnas* better than this one. — The smaller *A. ephippium*, just as *Premnas*, prefers an anemone, which is able to hide it. *A. ephippium* does not like open patches; that may be the reason why fullgrown individuals are thrown on 5 and do not like 3 so much, of which the young of *ephippium* are fond. *A. polymnus* is a fish which likes open water. That may be the reason why it does inhabit no. 3. It also inhabits (indeed prefers) anemone 2 with its shorter tentacles, which seems to prefer rather open places. It may be that the very large size of this anemone replaces the length of the tentacles which the other damselfishes demand for hiding. — The small *A. percula* inhabits anemones 1 and 4. Fishes as well as anemones in this case like open places; small fishes are contented with short tentacles for their hiding; that may be the reason why the orange damselfishes besides anemone 4 even inhabit 1. This is made the easier because the latter, like no. 2, may be of large size. *A. akallopisus* finally, being little larger than *percula*, like the latter inhabits anemone 4.

Finally one may ask why the small species of damselfishes never inhabit the anemones of the larger damselfishes, especially no. 5. For even where 1 and 5 grow close together we may find several *percula* in one specimen of anemone 1 and none in 5. Aside from the improbability of such behaviour for other reasons, I believe that the territorializing habits of *Premnas* and *Amphiprion ephippium* make such a thing impossible. If *Premnas* inhabits two anemones already, it will accept a third one if there are no rivals of its own species. And only if in very open places anemones 1 and 5 would occur together, it would be possible that the latter became inhabited by an orange damselfish. See, moreover, page 346.

I should like to add that such a reasoning, as set forth here, has many dangers. I feel, however, that a large number of observations, made on the reef and in the aquarium, gradually has succeeded in satisfying my thirst for information in this respect. And though risking the chance of being called unscientific, I give these conclusions for what they may be worth.

Certainly it would be much more acceptable for us to learn that the symbiosis of fish and anemone is based on chemical properties of the latter alone. It would seem reasonable to assume that a certain fish from the beginning based its symbiosis on chemical peculiarities of its anemone, e.g., in showing an immunity against its poison. We see, however, that *percula* inhabits such very different anemones as 1 and 4, of which the first sticks very strongly, the latter hardly. *A. ephippium* in the aquarium inhabits no. 4, in nature 2, 3 and 5. *A. polymnus* inhabits 2 and 3 and in the aquarium accepts 5 and 1. This means that these fishes are immune to the poison of all five species of anemones here treated and that, though they may perhaps identify their anemone by its



chemical properties <sup>1)</sup>), the symbiosis nevertheless is based on other peculiarities of the anemone, mentioned before.

In dealing with the experiments quoted above we learned that *Premnas biaculeatus*, when brought into a tank with four species of anemones, refuses three of them, and finally discovers and accepts the right one, though all these anemones offer quite the same surroundings to the fish. Moreover, as far as I know, young *Premnas biaculeatus* which — one should think — do not need a host with long tentacles, inhabit anemone 5 and not any other species <sup>2)</sup>). One would also think that these small fishes do not need deep holes as their parents do and, for that reason too, do not need 5. It therefore seems not improbable that for the fish species as a whole a distinct species of anemone, especially by its hiding powers and by its ecological wants, has so many advantages, that the fish, brought together with other anemones, does no longer search for an anemone and tentacles of a special size and an anemone with special surroundings, but identifies the anemone by its general character and chemical properties.

One is led to the conclusion that the symbiosis in this way grew from a general to a more specialized one and that the preference of the fish for a special anemone became inherited.

## 2. Observations on the association.

As already stated one anemone normally is inhabited by no more than two fishes, a male and a female. In fact, this holds for all *Premnas biaculeatus* and *Amphiprion ephippium* and most *Amphiprion polymnus* I met with. They are all very aggressive towards other specimens of their own species coming into their neighbourhood, especially if these are of the same sex. If two large females of *Premnas biaculeatus* are brought together in a tank, they fight very fiercely, even if there is no anemone; the same, though in a less pronounced way, happens when two males are brought in one and the same basin. Even two females, freshly caught in the sea, and transported in one tank, try to fight each other to death.

In fighting the females of *Premnas* bite each other especially in the head and in the dorsal fin. Biting in the flank appears to occur only in sexually excited animals. — In *polymnus* I saw the biting (very fiercely) take place in the dorsal fin and in the tail.

The instinct of maintaining a distinct territory is very strongly developed in damselfishes. In this respect they are true Pomacentrids, a large number of which shows this characteristic of fighting for distinct territories. *Amphiprion percula*, however, differs in this behaviour from the other damselfishes. Even

<sup>1)</sup> Brock (1927, p. 223) has shown that *Pagurus arrosor* is able to find sea anemones, hidden under stones and invisible to the eye, at a distance of 35 cm by chemical sense alone. So it need not be impossible that *Premnas* too is able to "smell" its anemone.

<sup>2)</sup> One cannot be quite sure that such a statement is true, for these small young ones are difficult to find. We can only say that they were found in 5 only.



where it inhabits small anemones, we may find more than two fishes in one anemone, whereas large anemones often are inhabited by 5, 6 or even more specimens. The transportation or keeping of a large number of *percula* in one and the same tank gives no difficulties. Nevertheless a certain degree of territorializing occurs here too.

It is noteworthy that, though sometimes so many fishes live in one and the same anemone, *percula* possesses the same instinct of maintaining a definite territory. The assemblage of six or seven individuals here is the product of an equilibrium between the efforts of some fishes to drive off other specimens and the perseverance of other fishes in remaining. See below. — The same, though in a lesser degree, may be observed in *polymnus* and *akallopisus*. As to the first I twice found four specimens in one anemone (anemone 2), and though there was constant quarreling in both cases all four remained together<sup>1)</sup>. As to *akallopisus* this species is so mobile that it is difficult to make out whether 6 or 7 specimens, inhabiting a large group of anemone 4 (Pulu Dapur), each inhabit their own anemone, or whether they mix at random. I got the impression that the latter was the case. Nevertheless, *akallopisus* is very aggressive towards other fishes (damselfishes included) coming into its neighbourhood. — It is worth mentioning that *Amphiprion akallopisus* and *A. polymnus* possess a peculiarity, which is lacking in the other damselfishes here treated. In pursuing another fish coming into the neighbourhood of their anemone they make a grating sound, like "krrrr". In *akallopisus* this sound is produced through rapid up and down movements of the opercula, in *polymnus* through a movement of opercula and mouthbones. The sounds are so loud that they may be heard some distance outside the aquarium or when one dives in the neighbourhood of the fishes. — All sounds made by fishes are either made by scraping of parts of the skeleton or by movements of the swim bladder. It has long been held that such sounds must of necessity be meaningless to the species in question or to other fishes because fishes were believed to be deaf, but recent investigations, especially those of STETTER (1929), have distinctly shown that fishes may "hear" quite well. His *Phoxinus laevis* heard as well as or better than human beings and one is quite astonished to learn their powers of sound discrimination. The question by which organ these sounds are perceived has now in so far been solved, that we know fishes really hear, i.e. perceive the sounds with their ears, sacculus and lagena probably playing the chief role (VON FRISCH, 1929).

Whereas in the small *Amphiprion percula* one anemone, especially if it be a large one, is sufficient for two or more fishes, the larger damselfishes, if the anemones are present in sufficient numbers, often inhabit two or even three anemones growing in each other's neighbourhood. In such a case one often observes that one of the two fishes inhabits one, and the other of the two another anemone, both fishes swimming up and down between their hosts, but both still adhering more or less distinctly to their private anemone. Occasionally also in *percula* and perhaps regularly in *akallopisus* (see above) one couple may be found inhabiting three or more anemones when these are living close together.

All damselfishes feed on organisms found in the neighbourhood of their habitat. For the small *Amphiprion percula* and probably also for *akallopisus*

<sup>1)</sup> Since the above was written, I saw (with diving helmet in deeper water) several times more 4-5 specimens in one enormous anemone 2, but I made no observations on their behaviour.



the organisms are minute planktonic and benthonic ones, which are found in the water in close neighbourhood and on the tentacles, oral disc and columnwall of the anemone and even on the coralrock or sand bottom surrounding it. A great part of the day (little during the afternoon) they may be seen busily feeding. They do not swim more than 5-15 cm away from the anemone, as the latter protects them and they might become an easy victim to fishes of prey. The same holds good for the young ones of other species.

SLUITER observes the following on *Amphiprion percula*: „Auch die Nahrung bekommen unsere Fische mittels ihres Gastfreundes. Die Beute, welche die Actinie macht, wird nämlich von ihnen ausgenutzt, ehe dieselbe in den Magenraum der See-Anemone hinabgewürgt wird. An den der Actinie gereichten Stückchen Fleisch zerren und zupfen sie, bis sie kleine Fasern abgezogen haben, welche sie auffressen. Auch die Fettschmelzen, welche die Actinie wieder auswirft, werden noch von ihnen aufgefressen”.

The larger the fishes grow, the more they become independent of the anemones for getting food from their tentacles or from the immediate neighbourhood. For as they grow larger they no longer feed upon the minute organisms forming the food of their youth. I cannot say, however, on what organisms these larger damselfishes do feed in nature. During visits to the reefs one frightens the fishes and does not learn much about their feeding behaviour, and in the Onrust Aquarium one rarely gets an opportunity to see them catching their normal food, as the water of the aquarium is pumped up from the deeper surface water of the sea and contains little more than small planktonic organisms on which a large fish like *Premnas* feeds little or not, though it must be stated that even the rather large *Amphiprion ephippium* and *polymnus* get at least a part of their food from this source. If, however, one places young fishes (I used young *Plotosus*) into the basin of *Premnas*, it starts catching them and shows an ability in this direction which one would not expect in this species; *Amphiprion polymnus* and *ephippium* do not bother very much about such food, it probably being, as long as it is alive, too rapid for *polymnus* and too large for *ephippium*. The inhabitants of the Onrust Aquarium further once a week or rarer get *Mysis* or dead *Stolephorus* (cut to pieces) as food. This food is eaten by all five species of damselfishes with great avidity and especially *Amphiprion polymnus* and the large female of *Premnas* may be seen swimming towards the food a long distance (one metre or more). It is nice to see how the particles chosen for food are smaller in proportion to the smaller size of the species of damselfish, which is concerned.

From the observations given above it follows already that the larger damselfishes are less strongly attached to their anemone and may be seen swimming away up to several metres. They need a larger field of operation because they need more food and can afford it as they have not to fear so many enemies. For that reason too the anemones, which are inhabited by one pair of these fishes, sometimes stand rather far apart, the fishes swimming to and fro from one to the other. *Amphiprion polymnus* shows this tendency of swimming out



for food over greater distances — several metres — still more strongly pronounced than *Premnas biaculeatus* and *Amphiprion ephippium*. In the Onrust Aquarium, when the fishes are fed, *polymnus* for that reason is one of the most interesting inhabitants. It swims out to all parts of its tank, searching for food which sank down to the bottom; this food is taken up and rapidly conveyed to the anemone after which the fish no less rapidly returns to the corners of the tank to fetch new food for its host (see below). By this behaviour the species sometimes becomes the victim of the native fishbaskets or "booboos". These are laid out on the reefs or hung in the water by the natives and attract fishes which like to hide themselves in them or visit them for other reasons. *Amphiprion polymnus*, though it is rarer than *A. ephippium* or *Premnas*, is sometimes caught in them, whereas I know of only one *Premnas* and no *A. ephippium* having been caught in this manner <sup>1</sup>). Another fact, resulting from the behaviour of this fish, is that mature *Amphiprion polymnus* are more difficult to catch than adult *Premnas*. For as soon as *polymnus* is pursued, it leaves its anemone, instead of hiding itself in it, swims away a good distance and returns after some time to its home to see if danger is over. *Premnas*, on the contrary, always remains in close vicinity of its anemone and as it often does not hesitate to attack the intruder, bite his legs, shoes, net, etc., it is easily caught <sup>2</sup>). *Amphiprion ephippium* may attack one or swim away short distances, but it is always more dependent on its anemone than *polymnus*.

I did not yet mention the habit of the damselfishes to feed on the anemones they inhabit. From the appearance of the latter it may perhaps be concluded that they do so regularly; I have, however, only few direct observations concerning this habit.

These observations are the following:

On February, 14, 1929, the female of *Premnas biaculeatus* bit a mouthful of tentacles from its anemone and swallowed them.

On July, 26, 1929, the female of *Premnas* bit off about six times a mouthfull of tentacles, which were eaten.

On December, 2, 1929, the specimen of *Amphiprion polymnus* bit a long tentacle from anemone 5 and ate it; it then took some more and swallowed to or three together.

On May, 24, 1930, the female of *Premnas* bit some tentacles from its anemone and swallowed them.

I may add at once that the damselfishes are not the only fishes which are able to eat anemones. PAX (p. 806) enumerates a few others. On the other hand POULTON found that aquarium fishes (see page 337), when fed with pieces of *Adamsia* or *Suberites*, wildly rejected them. We have no right to claim that those other fishes eating anemones, like damselfishes are immune against the poison of anemones, as the latter perhaps does no harm when it is ingested per os. PAX (p. 796) rightly

<sup>1</sup>) It should not be forgotten, however, that *polymnus* probably lives deeper than other damselfishes, and for that reason will encounter the booboos more often than the latter.

<sup>2</sup>) We find this very strongly developed instinct to maintain a territory in several Pomacentrids; one species, which lives between dense patches of *Acropora hebes*, can be decidedly troublesome during one's reefwork.



remarks that „auch die Küstenbevölkerung in manchen Teilen der Erde (Grönland, Mittelmeerländer, Südsee) Seeanemonen zu Speisezwecken verwendet“, though „manche an zoologischen Stationen tätigen Personen gelegentlich an einer hartnäckigen Urticaria erkranken, wenn sie häufig mit Seeanemonen in Berührung kommen“. The Malaysians from the neighbourhood of Batavia too use the large specimens of anemone 1 for food, though this species sticks strongly and stings severely. It is quite another thing with those invertebrates which feed on anemones; they must be immune against the poison as they touch the anemones with their whole body. It is interesting to learn what is known in this respect about the snails of the genus *Aeolis* (PAX, p. 806). In the Bay of Batavia probably one of the worst enemies of anemones as well as of the corals is the large starfish *Acanthaster echinites*, which in two or three days devours a large specimen of anemone 1 and feeds principally on the living tissue of the madreporarians. Other invertebrate enemies of anemones mentioned in literature are *Trochus zizyphinus* (see FLEURE & WALTON) and *Pycnogonum littorale* (PAX, p. 806).

Not only do the damselfishes feed on the tentacles of their anemone; already SLUITER mentioned the fact that they also eat the waste matter (food remnants) of the anemones, which the latter throws out through its mouth. The fishes have indeed the habit of picking in the "corners" of the mouth of the anemone, even if there is no food at all; especially *percula* may show this behaviour.

The damselfishes not only feed on their anemones, however, they also bring them food. I already mentioned that *Amphiprion polymnus* searches its basin for food and brings it to the anemone. In fact, the feeding instinct of this fish gives us a most remarkable example of an organism which takes care of another organism in an apparently very purposeful way. When *Amphiprion polymnus* is fed it only eats very small particles in the water between surface and bottom. It is the way in which *polymnus* is hunting for plankton in nature too. The larger particles of food, however, are not eaten, but grasped by the mouth and brought to the anemone. The fish swims to the latter and puts the food (prawn, piece of a fish, etc) on or between the tentacles. If there are large food particles only, too large to be eaten by the fish, it brings all of them to the anemone, without eating anything itself. The specimen of *Amphiprion polymnus* in the Onrust Aquarium may be seen conveying several tens of small *Stolephorus*, if they are available, to its anemone, and when it has two anemones, it may be seen to feed both, choosing the anemone nearest to the particles in question. Nature, by its use of instinctive behaviour, does not provide means for anticipating the results of such abnormal happening: the anemone gets too much food and part of it, if it is not rejected at once, is ejected after some time. We will see below that then again the fish may be of much value to the anemone in carrying away the rejected food. — This remarkable feeding behaviour is most markedly shown by *Amphiprion polymnus*. In a less conspicuous way it is shown by *Premnas biaculeatus* (male and female). *Amphiprion ephippium* has the instinct still less developed. It usually tries to grasp some prawn or pieces of fish, but as its mouth is very small, it usually loses its prey before the anemone has been reached, and after



some unsuccessful trials it gives up the attempt. Moreover it very rarely takes up food from the bottom, as *polymnus* always and *Premnas* sometimes does, but nearly always only grasps it while it is in the water. *Amphiprion akallopisis* and *percula* never have been seen to fetch food for their host animal, so these fishes probably do not possess the instinct in question; they feed on small organisms, apparently without being interested in larger ones, and leave their anemone only for very short distances.

The feeding of its anemone by *Amphiprion polymnus* was described by SLUITER already. „Ein recht fesselndes Schauspiel zeigt sich, wenn man ein grösseres Stück Fleisch in der Nähe der Actinie ins Wasser wirft. Unser Fisch — denn ich fand immer nur einen bei der Actinie — lässt das Stück bis etwa 2 dm von der Actinie hinabsinken, kommt dann schnell aus seinem Schlupfwinkel heraus, packt das Fleisch, das sogar mehr als halb so gross als er selbst sein kann, schleppt es mit sich, und drückt es mit einigen kräftigen Schlägen des Schwanzes gegen die Scheibe und Tentakel der Actinie. Letztere wird hierdurch aufgefordert, das Fleisch mit den langen Tentakeln zu umfassen. Jetzt zieht und zupft unser Fisch wieder kleine Fasern von der Beute ab. Hat aber die Actinie das Stück bis zum Munde hinbefördert und fängt sie an es in den Magendarm einzustülpen, ohne dass unser Fisch sich noch satt gegessen hat, so zieht letzterer es aus dem Munde hervor und bringt es wieder mehr an den Rand zwischen die Tentakel, wo er mit seiner Zupfarbeit weiter schreiten kann". This description may give one the impression, however, that the fish only conveys food to its anemone to find a comfortable feeding place between the tentacles. I therefore add at once that this is not at all the case. It is true, that sometimes the fish (*Premnas biaculeatus*, *Amphiprion ephippium* and *polymnus*) eats of the food brought to the anemone by itself, but this is not the rule, the contrary being true. There is no doubt the feeding of the anemone is "primair" here, though it may have originated (if it did originate in Darwinian way) as a bringing of food to the sheltered house.

I already mentioned that the fishes, except feeding their anemones, still in another way take care of them, namely by "treating" the anemones. If a newly collected anemone is brought into a basin with a host-less damselfish, the latter immediately begins thrusting its head between the tentacles and rubbing with its flanks against the upperside or columnwall of the latter. Even if the fish was already in possession of an anemone, it may leave its host to try and occupy itself with the new one. It swims up and down, to and fro, waving its great pectoral fins, diving head on or sideways in the anemone and does not stop till the condition of the anemone has improved and it is beginning to expand. Especially the large *Premnas biaculeatus* has this instinct of care for its host very strongly developed, whereas the small *Amphiprion percula* in this respect is a much less perfect partner.

#### NATURE OF THE ASSOCIATION.

After having studied the life-history of fish and anemone in somewhat more detail, we now may ask with what kind of association we are dealing here. The chief point of interest is: in how far are the fishes able to live without



their anemone, in how far can the anemone do without a fish? I know that it is dangerous to pass judgment on such a delicate problem. On the other hand a careful consideration of the principal facts may teach us more than ignoring the problems.

As far as can be seen from the observations enumerated, the fishes could profit by their association with sea anemones by: 1 the protection which the anemone gives them, and 2. the source of the food, the anemone provides for them; the anemone could profit by 1. the renewing of the water and the rubbing of the fishes, 2. the removing of waste products by the fishes; 3. the food brought to them by the fishes. We will treat these different points in greater detail now.

1. The anemone affords protection to the fishes. I already remarked (page 307) that an independent life for the fish is an impossibility on account of the danger caused by fishes of prey. SLUITER remarked the same.

He says the following concerning *Amphiprion percula*. „Der grosse Vortheil welchen unsere kleinen Fische aus diesem Zusammenleben ziehen, besteht offenbar darin, dass sie zwischen den Tentakeln der Actinie gegen die Nachstellungen grösserer Fische gesichert sind. Ich habe öfters beobachten können, dass den Fischen, wenn ich sie ohne die beschützende *Actinia* in meine Aquarien brachte, unmittelbar von den grösseren Fischen nachgestellt und sie aufgefressen wurden. Sie suchen zwar einen anderen, ihnen mehr oder weniger zusagenden Gegenstand als Schutz, z. B. ein vielfach verästeltes und zackiges Korallenstück, ja einmal sah ich sie sogar sich zwischen die Stacheln einer *Echinothrix calamare* flüchten <sup>1)</sup>. In kurzer Zeit aber fallen sie unumgänglich ihren Feinden zum Opfer. Mit der *Actinia* habe ich sie schon mehr als sechs Monate am Leben erhalten.“

As some of the species of damselfishes move only very slowly and do not possess an instinct for hiding, they are — especially when young — incapable of maintaining themselves against the numerous predatory fishes of the genera *Lutianus*, *Epinephelus*, *Scorpaenopsis*, etc., inhabiting the reefs. Experiments which I made for quite another purpose showed that the only reason, why the small damselfishes do not leave their anemone, is that of danger <sup>2)</sup>. On November 30, 1929, I put 9 *Amphiprion percula*, which had lived in the aquaria in Batavia from September 15, 1929, onward, in one of the tanks of the Onrust Aquarium, to see if they were not damaged by the poison of the anemones after having been without them for such a long time. This was not the case, but the experiment showed me quite another thing. The fishes had become accustomed to aquarium surroundings and were quite tame. They found the anemones, and now and then dived into them, but during most of the day they swam through the whole tank, little bothering about the anemones on the bottom. In the evening, however, they all disappeared between the tentacles of the latter, remained there hidden during the night, to reappear the following morning,

<sup>1)</sup> It is quite interesting that the spines of this species and especially the long ones of *Diadema saxatile* are regularly used for safe retreat by several species of fish. This has nothing to do with symbiosis or some other form of more or less close association; the association is quite facultative.

<sup>2)</sup> The assertion of SAVILLE-KENT and others that the fishes may enter the mouth of the anemone and remain hidden in the gastric cavity, is false. They never enter the mouth.



and recommence their surface-life. After two days, when I took them out again, they still behaved in quite the same way, playing and searching for food in the whole tank and only now and then diving into or swimming between the anemones. And this, notwithstanding the fact that a pair of *percula*, together with its anemone taken from the sea and at once transferred into the Onrust Aquarium nearly two years ago, still shows the same fear and adheres in the same way to its anemone as in nature. These fishes from Batavia had lost their fear and therefore did no longer need the close association with their host.

This association is quite close. I can only confirm SLUITER's observations on this point. „Sobald man sie (die Fische) mit der Hand oder sonst etwas bedroht, flüchten sie sich schleunigst in den Tentakelwald zurück. Ja sogar, wenn man die Actinie mit dem Korallenstücke, auf welchem sie befestigt ist, aus dem Wasser heraushebt, geben die Fische sich lieber mit ihrem Gastfreunde gefangen, als dass sie ohne Schutz ihrem Untergang entgegen gingen. Eben deswegen ist es auch sehr leicht, der Fische zugleich mit der Actinie habhaft zu werden". This, however, as already remarked, holds for *percula* and the small young of other species only.

2. The anemone provides the fishes with food. As already stated the fishes — especially the young ones — get part of their food from the tentacles and the oral disc of the anemones. It is not likely, that they cannot live without this food, which is, in fact, the same food as that taken from the water: plankton. They will, however, during this feeding behaviour, also digest mucus and nematocysts of the anemones. Further they feed — probably regularly — on the tentacles of their host and on its food remnants. Taking into account the observations of CANTACUZÈME & COSMOVICI on *Eupagurus prideauxi* and *Adamsia palliata*, one will be inclined to assume that this food may serve to make the fishes immune. CANTACUZÈME assumes that immunity of the blood of *Eupagurus prideauxi* is caused by the ingestion of nematocysts of *Adamsia palliata*, which occur plentifully in the digestive tract of the crustacean. Accordingly I had expected that this also could be the case in damselfishes; I therefore hoped that fishes which for a long time had had no opportunity of taking in nematocysts, would have lost their immunity. I therefore made the experiment quoted above, in putting 9 *Amphiprion percula*, which had not seen an anemone for 76 days, in a basin with many anemones (4 anemone 1, 7 anemone 4, 3 anemone 2, 1 anemone 5). The result was quite different from what I expected. The fishes at once started diving into and swimming between the anemones and there was no question of a lost immunity. This was also the case with a male and female *Premnas biaculeatus* which had lived in Batavia for about 176 days and 14 days respectively. Young *Plotosus*, which were put in the aquarium in these same days, were captured by the anemones as soon as they came in contact with them. — As far as I could make out young damselfishes, seeking anemones, at once come in contact with them, without having any noxious influence from the poison; but I am not quite sure about this.

As far as these observations allow of a conclusion, we may say that it is not very probable that the fishes need an uninterrupted contact with their ane-



mones to keep themselves immune; neither is it made probable by what we have learned, that the fishes need their anemones as a source of food. It must, however, be remarked, that even 176 days of aquarium life are not sufficient to warrant the conclusion that the immunity of the fishes is an inherited one. More experiments in this direction are necessary; they are in progress in the Onrust Aquarium now and will cover a long period.

Before leaving this subject I must not forget mentioning an observation of December, 2, 1929. I already described how a male of *Premnas biaculeatus* succeeded in finding one specimen of anemone 5 between a large number of other anemones. This male — as already stated — had been in Batavia for 176 days. On December, 30, it had been for some hours in another basin and had been in contact there with an anemone for a short time. Now, after having found the specimen of anemone 5, the fish started at once with a very remarkable behaviour. It took the tentacles of its newly obtained anemone in its mouth the one after the other, without biting them off, however, but only to let them slip and take another and still another one. The whole proceeding suggested that it was eating the mucus covering the tentacles and nothing else; I counted the fish treating about 30 tips of tentacles in this way, but it thereafter continued its work for a long time and may have treated some hundreds of them. Such an observation makes one hesitate to assume that the fish can do quite well without its anemone.

We now have to see in how far the anemone may profit by the presence of the fishes.

1. The fishes are constantly removing the water from the neighbourhood of the anemone and rubbing the latter. I already treated this point in some detail. It appears not very probable that the anemone often owes its life to this behaviour of the fishes. Only when conditions are very bad will the fishes be of some influence in this respect. Already the fact that specimens of anemones 1 and 3 may occur without fishes in nature, shows that these anemones can do without them. I do not deny the possibility, however, that the anemones are under better conditions when helped by the fishes than when they are not. It even must be very probable, that the constant moving about of the fishes is advantageous to them. The experiments in the Onrust Aquarium are not conclusive on this point: anemone 5 lived without a fish from 19 II to 2 XII, 1929, after which period it did rather well, another specimen of anemone 5 lived from 30 Nov. 1929 to now, Nov. 1930. Anemone 5 doubtless is one of the most exacting species of the anemones here treated. On the other hand SLUITER's observations seem to have shown the contrary. SLUITER says concerning anemones of *A. percula* (I translate in English): "I could keep alive these anemones only a short time, at most 15 days, without the fishes; some anemones with fishes, however, have now already been living in my aquarium six months and they look as healthy as when I got them from the reef" (SLUITER, 1887). Though SLUITER did not mention these observations in his paper of 1888, his statement is so positive, that we cannot neglect it. — It may be that the conditions in the Onrust Aquarium



are so favourable that fishless anemones remain alive quite well, whereas SLUITER's aquaria offered somewhat less favourable conditions so that his anemones died when deprived of their fishes.

2. The fishes remove the waste products of the anemones. Generally speaking this must be of very little advantage to the anemone. One can imagine, however, that under unfavourable circumstances, when the anemones produce much waste matter and when they have only little oxygen at their disposal, the anemones may profit somewhat by the presence of the fishes in this respect.

3. The fishes give the anemones food. This is another point, of which it is difficult to estimate the real value. BOSCHMA, TRENDLENBURG and others seem to me to have shown <sup>1)</sup> that corals and anemones use part of their zoöxanthellae as food. BOSCHMA comes to the conclusion that they prefer animal food, but that they digest their zoöxanthellae when animal food is not available. Now, the quantity of plankton present in tropical seas is notably small. The animal food large reef anemones catch must be of very little importance. The fact, however, that they prefer animal above vegetable matter may show that they need a certain amount of animal food for their well being. This animal food, in those cases where the anemones are inhabited by larger damselfishes, is partly furnished by the latter and one may assume that these fishes are of real value to their host. As far as we may conclude from the observations present, the anemones in the Onrust Aquarium thrive best when they were fed from time to time. Observations over a longer period are necessary, however, to prove this definitely; such observations are now in progress in the Onrust Aquarium. — It should not be overlooked, however, that the small anemone fishes, *Amphiprion percula* and *A. akallopisus*, as far as could be made out, never feed their anemones, and yet the latter thrive.

Recapitulating the points of interest we see that: the fishes depend on the anemone for protection, which is already rendered probable by the fact that they never occur without them in nature; that we do not know whether the fishes need part of the anemones as food (or for immunisation); that it is probable that the movements of the fishes are advantageous to the anemone, especially when the latter is in poor condition; that we do not know whether the clearing of waste products by the fishes is advantageous to the anemones; that finally the anemones, which are fed by the fishes, probably profit much by the presence of the fishes in this respect. The difficulty of pronouncing a definite opinion on the question, whether both partners take advantage of their living together, is still enhanced by the fact that there are different grades in the closeness of the association in the different species, and by the peculiar case of the association in *Premnas*-anemone 5.

*Premnas*, as far as we know, does not accept other anemones than number

<sup>1)</sup> I am cautious in choosing my words because YONGE in his preliminary reports on the work of the Great Barrier Reef expedition has communicated that according to his findings zoöxanthellae are not used as food by the corals, though they are used as such by *Tridacna*.



5<sup>1)</sup>. It feeds its host, though in a less devoted manner than *polymnus*. But moreover *Premnas* helps its anemone in another way. I already remarked that *Premnas* seems to be the only damselfish showing a strong preference for holes and that this may be the reason for its close association with anemone 5. This anemone inhabits deep holes in and between the corals. One often wonders how these holes came into being. For they may be perpendicular holes in living colonies of Poritid and Astreaeid corals, which may be more than half a metre deep. Now, in the Onrust Aquarium, it was quite interesting to see how *Premnas*, shortly after having been brought into the basin, deepened out a hole under its anemone by loosening pieces of coral shingle of the tank bottom with its mouth, removing them to a small distance and depositing them there. Later on, when a piece of coral, on which an anemone was attached, was laid down near the anemone of *Premnas*, the large female *Premnas* picked it up and removed it in the same manner. This behaviour was repeated several times and could be studied at length. I therefore am inclined to conclude that it is *Premnas* which deepens out already existing small holes in the large colonies of corals, in which anemone 5 has settled.

If all such facts concerning the care of the damselfish for its anemone (rubbing, cleaning, feeding, digging) are taken into account, we may — it seems to me — only conclude that the presence of the fish (at least in the case of the larger species) must be of advantage to the anemone and that both partners profit by their association.

So, in conclusion of this chapter, we may return to the question we put at the beginning. What is the nature of the association? — We may answer then that in the small *Amp. percula* the association may perhaps be arranged between something like commensalism and true symbiosis, though the facts perhaps can also be interpreted as indicating bare commensalism, indicating by this word that one of the partners takes advantage of the association without it being noxious to the other. In the case of *Premnas*, however, we have — to my mind at least — an example of very true symbiosis, using that term for that kind of association between two different species, in which at least one of these organisms is unknown to live independently (mutualism). I think we are dealing here with one of the most ideal and most remarkable instances of true symbiosis one may imagine. I add once more that this is only a confirmation of SLUITER's conclusions in 1888.

#### COMPARISON OF THIS CASE OF SYMBIOSIS WITH SOME OTHERS.

It is worth while to compare this case of symbiosis with some others, which are no less remarkable.

In dealing with the association between anemones and fishes it is interesting to compare what is known about symbiosis of fishes on one and of anemones on the other hand.

<sup>1)</sup> See, however, note on page 319.



Of the cases of association between fishes and other animals one of the most remarkable and closest is doubtless the symbiosis existing between the Scorpaenoid fish *Minous inermis* ALCOCK and the hydroid *Podocoryne (Stylactis) minous* (ALCOCK) (vide GUDGER, 1928). The fish bears the hydroid on its body, especially on the shoulderregion and the parts back of the pectorals and the forwardly placed pelvic fins as far as the vent. Whereas all 31 specimens of *M. inermis*, which are known, bear the hydrozoön, the hydroid till now has not been found without its fish, so that it is quite probable, that we are dealing with a case of true symbiosis here. However, we do not know any particulars about the life-history of the symbionts. — For further cases of association between fishes and Hydrozoa vide GUDGER 1928; none of these cases seems to relate to true symbiosis.

I pass over the other cases of fishes living in association with other organisms (fishes in sponges or in medusae, *Syngnathus* and *Fierasfer* in Holothurians, *Fierasfer* in starfishes and oysters, *Apogonichthys strombi* in *Strombus gigas*, vide DEAN, Vol. 3, p. 395) without discussing them, as next to nothing is known about their life-history and the closeness of their association. All these cases do not teach us anything in connection with the foregoing chapters.

Of the examples of symbiosis between sea anemones and other animals the most classic one is the case of symbiosis between anemones and hermit-crabs. Much less common is the symbiosis between anemones and crabs, though especially here we find cases of great interest: *Stenorhynchus phalangium* and *Anemonia sulcata*, *Hepatus chilensis* and *Antholoba reticulata*, *Lybia* and *Polydectus* and *Bunodeopsis*, *Dorippe facchino* and *Cancrisocia expansa*. Finally we have to mention the symbiosis between sea anemones (*Stoichactis*) and the shrimps *Ancyllocaris brevicarpalis* SCHENKEL and *Thor discosomatis* KEMP.

Of these cases *Stenorhynchus phalangium* PENN. lives with its anemone (*Anemonia sulcata* PENN.) (THOMSON, 1923) in about the same way as the damselfishes live with theirs. The crab "takes up its position close to the column wall of the anemone, so as to be more or less concealed by the tentacles, only the rostrum and the first pair of walking legs being visible from above, whilst the legs of the fourth pair may reach backwards to grasp the anemone. But at times, and especially when disturbed, the crab climbs backwards right on to the crown of the anemone; and one specimen, a female bearing eggs repeatedly worked its way right under the base of the anemone, so that only the tip of the rostrum and the limbs could be seen. The anemone makes no attempt to seize the crab, but if the crab dies its body is soon lifted up and devoured." As all specimens of *Stenorhynchus* observed behaved in quite the same manner and as the crab must be immune to the poison of the anemone, there is no doubt that we are dealing here with a case of true symbiosis, quite comparable with that of the damselfishes. *Anemonia sulcata*, like the reef anemones of this paper, is diurnal, *Stenorhynchus*, however, seems to be more nocturnal than diurnal. Food which is being found by the crab and brought to its shelter to be devoured, may be taken by the tentacles of the anemone, and the latter eats it. This



may be an indication that, in *Amphiprion* and *Premnas* too, the "feeding" of the anemone originated as a bringing food to the place of shelter. The undigested remains, given back by *Anemonia sulcata*, are eaten by the crab, just as in the case of the damselfishes.

The association between anemones and shrimps does not differ much from these cases. One of the specimens of anemone 1 living in the Onrust Aquarium is inhabited by such an animal <sup>1)</sup>. Just as in the case of *Stenorhynchus* and damselfishes the chief advantage the anemone offers seems to be that of protection. The shrimp is most of the day walking about on the sandbottom of the basin close around the anemone, searching for food among the detritus matter all the while, and only now and then walking over the tentacles of the anemone. Though it is able to do this, it prefers walking over the column-wall, whence it may go down to the sandbottom to use the columnwall as a retreat. This animal surely does not feed its anemone nor is it probable that it depends for food on the anemone; it only depends on the latter for retreat.

We now come to cases where the anemones do not remain at one and the same place but are transported by the crustacean. Of these cases the association of *Hepatus chilensis* and *Antholoba reticulata* (BÜRGER, 1903) be mentioned first. *Antholoba* is rarely found on immovable objects as stones or bivalves; it is nearly always attached to moving organisms: *Pecten* or shells of *Purpura* inhabited by a Pagurid. Most of the time, however, at least there where crab and anthozoön inhabit the same region, the anemone is attached to *Hepatus chilensis*. Of 60 specimens of this crab collected by BÜRGER, only four were without their anemone. From these facts follows that both animals can live independently, and it is of great interest to know something more about the nature of their association. As it must be impossible for *Pecten* to put an anemone on its shell, the possibility exists that the anemones in this case search for moving objects and that they attach themselves to the crab too. This, indeed, after BÜRGER's observations seems to be case. „Einige Stunden später, hatte sich diese Actinie mittels ihrer Fuss Scheibe an das Bein einer Krabbe geheftet und hielt dasselbe wie eine Zange so fest umklammert, dass der Krebs die Seerose mit sich herumschleppen musste. Während der Nacht erklimmte die Actinie den Rücken der Krabbe. Denselben Vorgang habe ich noch zweimal verfolgt”.

Coming to cases where anemone and crab are regular associates, we have *Lybia*, bearing specimens of *Bunodeopsis prehensa* in its claws. Here the meaning of the association is quite clear, the anemone being used as a weapon. The chelipeds of *Lybia tessellata* are especially "adapted" to this bearing of actiniae. — Another actinian bearing crab is *Dorippe facchino*. We are dealing here with the representative of a genus, the peculiar build of which is closely related with its manner of bearing something on the back. In the case of *D. facchino* this is a small bivalve shell, *Tellina* or the like [according to ORTMANN (see also

<sup>1)</sup> As I did not yet succeed in catching other specimens, I do not know the name of this species, but we are probably dealing with *Ancyllocaris brevicarpalis*.



STEBBING, p. 136) sometimes a mangrove leaf] on which an anemone is attached. ALCOCK (1896, p. 279) remarks on this crab: "..... I have rarely found it without a protective bivalve shell and sea-anemone".

In all the cases mentioned above we are dealing with some form of association, in which it seems probable that the anemone plays a defensive role, whereas it is indifferent to the association whether the anemone remains in its place, attaches itself to other animals or is attached to other organisms by these organisms themselves. From the fact that in most, if not in nearly all cases the anemone may be found without its partner, whereas the latter does not or rarely occur without its anemone, we may conclude that the protection given by the anemone is the essential point of the association. We came to the same conclusion in relation to the damselfishes.

The classic instances of symbiosis we find, of course, in the association between anemones and hermit crabs. Hermit crabs, indeed, possess this instinct of associating themselves with other organisms very strongly developed. They are known (vide BALSS, 1927) to live in symbiosis with sponges (*Suberites*, *Ficulina*), Actinians (see below), Zoanthids (*Epizoanthus*, *Palythoa*), Hydrozoa (*Hydractinia*, *Hydrissa*), Bryozoa (*Conopeum*, *Cellepora*), which are all attached to the shell they inhabit; moreover inside the shells may live Planarians (*Emprostopharynx*, *Euprosthiostomum*, *Stylochus*) or Polychaets (*Nereis*, *Nereilepas*). In most of these cases, in which the associate is attached to the gastropod-shell of the hermit crab, there is no doubt that here again the protection the associate affords to its host is the essential point of the association. In *Hydractinia* the defensive polyps of the colony occur along the opening of the gastropod shell alone (HESSE-DOFLEIN, p. 269), for *Suberites domuncula* living in symbiosis with *Eupagurus cuanensis* THOMPSON (= *lucasi* HELLER) POULTON has shown that it is wildly rejected by certain fishes, when pieces of it are given to them as food.

The association of hermit crabs and sea anemones may show the most different degrees of closeness. „Im ursprünglichen Falle, der der häufigste ist, ist die Vergesellschaftung der beiden Partner noch eine losere. Dieselbe Actinienart lebt mit den verschiedensten Paguridenarten zusammen und umgekehrt kann auch eine Paguridenart sich mit den verschiedensten Actinienspezies vergesellschaften" (BALSS, p. 968). *Paguristes oculatus*, according to BRUNELLI, may be found associated with *Actinia equina*, though this species is wellknown to live independently (compare the case of *Stenorhynchus phalangium* and *Anemonia sulcata*). *Adamsia rondeletii* may be found associated with *Eupagurus* (*Pagurus*, *Paguristes*) *bernhardus*, *arrosor*, *deformis*, *maculatus*, *striatus*, *anachoretus*, *cuanensis*, and perhaps others. In other cases, however, the association is so close that crab and anemone rarely associate with other anemones or crabs. The classic instance, the symbiosis between *Eupagurus prideauxi* and *Adamsia palliata*, is so wellknown that it may be superfluous to mention details <sup>1)</sup>. To

<sup>1)</sup> It be remarked here that FAUROT, whose paper is not to be got in Batavia, seems to have found this anemone associated with *Pagurus striatus* and *Eupagurus excavatus*.



us it is of interest that crab and anemone are only to be found without each other when very young <sup>1)</sup>. The crab itself loosens the anemone from the bottom and attaches it to its shell. When later it removes to another shell the anemone is transplanted. The anemone seems always to be attached in such a position that its mouth is in the neighbourhood of the mouth of its host <sup>2)</sup>. Structurally and functionally the anemone differs from related ones, in relation with its association. That anemone and crab cannot live without each other is a false statement of even the most recent handbooks, see, e.g., COTTE, p. 5-12.

In other Pagurids, where the association is probably little less close, we find somewhat different conditions. Both *Pagurus deformis* and *P. asper* DE HAAN in the Philippines (COWLES, 1919) "almost invariably carry two different kinds of sea anemones on their shells; one, a large greyish brown form usually on the sides and another, much smaller, almost colorless form usually on the underside of the mollusk shell below the protruding head of the crab." *Diogenes edwardsii* (DE HAAN) bears the anemone on its cheliped. *Paguropsis typica* HENDERSON bears its anemone (*Mammilifera*) as a hat on its back, without using a shell; uropods and 4. pereopods bear stilets and chelae respectively, which are used to attach the anemone.

It will, however, be unnecessary to enlarge on further details concerning the symbiosis between hermit crabs and their anemones. For the sake of comparison one is tempted to mention COTTE's comparison of the association *Adamsia palliata*-*Eupagurus prideauxi* with the association between *Adamsia rondeletii* and some of its crabs, especially as COTTE's psychological reasoning is quite attractive. In reading such papers one becomes inclined to say that what *Premnas* is for its anemone among the damselfishes, *Eupagurus prideauxi* is for *Adamsia palliata* among hermit crabs.

When now the association between hermit crabs and their anemones as a whole is compared with that between damselfishes and their anemones, we find close resemblance in the nature of the symbiosis. There is no doubt that in hermit crabs too — notwithstanding the contrary assertions — the protection given by the anemone is the essential part of the association. It is true that ORTON has described how *Labrus bergylta* may seize a claw of the hermit crab and shake the crab out of its shellhouse without touching the anemone and COTTE (p. 13) too says that "*Ad. palliata* n'empêche pas les serrans de s'attaquer à *Eup. Prideauxi*". This only shows, however, that the crab is eagerly eaten. We already saw that there are fishes which like to eat anemones; this does not

<sup>1)</sup> "Marion fait observer cependant que vers 200-250 mètres de profondeur, dans nos eaux, *Eup. Prideauxi* n'est plus qu'un animal nain, décoloré et souvent privé de son actinie" (COTTE, p. 9).

<sup>2)</sup> ORTON has called attention to the fact that *Adamsia rondeletii*, when there is food on the bottom, is trailed about by its host, with its disc flat on the ground behind the hermit crab. According to ORTON the anemone is never sitting in a vertical position with its disc beautifully expanded, as in most drawings. See, however, the description of this case of symbiosis by BROCK (1927, especially p. 219), most of whose drawings have been made after photographs. In any case ORTON's remarks cannot be said to hold for *Adamsia palliata* and some other species. According to COTTE (p. 90) *Adamsia palliata* is always attached to the ventral side of *Eup. prideauxi*.



prove, however, that the *Adamsia* species and other anemones are not poisonous; see page 325-326. POULTON has shown that pieces of *Adamsia*, fed to "aquarium fishes" (abstract in Zoologischer Bericht, Vol. 5, abstr. 642), when swallowed, are at once rejected. Moreover other observations show that the anemone indeed does protect its crab, see, e.g., EISIG's observation in HESSE-DOFLEIN (p. 271). And I refer once more to the experiments of COSMOVICI and CANTACUZÈME. — As with damselfishes it is probable that the movements of the crabs are advantageous to the anemone, especially when the latter is in poor condition. — It is improbable that the clearing of waste products through the crabs is advantageous to these anemones, as they are not sessile animals like the anemones of damselfishes. — It is very probable that the anemones which are indirectly or directly fed by the crabs, profit much by their association with the latter. They are fed indirectly when — compare ORTON's note on *Adamsia rondeletii* — they are trailed over the bottom with expanded disc or when (as certainly will be case in other species) they feed on the food of the crab (compare *Stenorhynchus-Anemonia sulcata*). They are fed directly if WORTLEY's statements in this respect are trustworthy: "WORTLEY has reported that the hermit crab when feeding may transfer pieces of food with its pincers to the sea anemone, but this behaviour has not been observed by me nor, so far as I know, by other workers. In fact the accuracy of WORTHLEY's observation has been doubted" (by EISIG, vide COWLES, p. 84). Taking into account the behaviour of damselfishes, it may be quite possible that this statement is true and that here too fishes and crabs are colleagues. — Finally hermit crabs, when hungry, seem to eat anemones (BROCK, 1927, p. 212). — All in all we may conclude that the association with anemones of both damselfishes and hermit crabs is based on the same "principles". In comparing details we find that the closeness of the association differs as much among the different species of hermit crabs and their anemones, as it differs among the species of damselfishes. This is, to my mind, not the least interesting finding in the above comparison. It strengthens the resemblance between the two associations here treated.

#### THE PROPAGATION OF THE FISHES.

As stated before the two damselfishes inhabiting an anemone are male and female. In *Amphiprion ephippium* and probably also in *akallopisus* and *polymnus* they have approximately the same size, in *A. percula* and *Premnas biaculeatus*, however, they differ considerably in size, the female being the larger. I give here the maximum sizes in mm. The figures in brackets indicate the numbers sexed and measured; only large individuals were dealt with.

Sex	<i>Premnas biaculeatus</i>	<i>Amphiprion percula</i>
♀	156 (4)	77 (13)
♂	107 (3)	60 (12)



As may be seen from the figures given above in *Premnas* especially the difference between male and female is strongly pronounced, so that one may find couples in which the female is thrice as large as the male.

Doubtless male and female often match for life. In some places the couples live so isolated that one looks in vain for more than one couple on a large stretch of reef. For that reason alone it must be hardly possible for the fishes in such places to find another mate in case they leave each other. But also in places where damselfishes are very common, it is undoubtedly the rule for the two partners of a couple to remain together, as they rarely leave their anemone. Moreover observations on the reef, insofar they go, confirm this supposition. The great variability in *Premnas* makes it possible to recognize individual specimens by the size of their white bands. A certain couple on the reef of Onrust now is known to have inhabited a certain anemone for several months already <sup>1)</sup> though many other specimens of *Premnas* live quite close to them and an exchange of specimens would be easily possible. Lastly, the fighting instincts of these fishes against other specimens of the same sex must, as in all typical monogamic animal species, be a strong means to keep the pairs together.

Although then, a male and a female remain together all the year round, propagation is apparently restricted to certain periods of the year. In this connection the different species probably show some differences. It may be remarked, however, that the available data were all furnished by the fishes in the Onrust Aquarium and that only for *A. percula* the observations have been confirmed by observations made in the sea.

*Premnas biaculeatus*, *A. ephippium* and *A. percula* with their anemones were brought into the Onrust Aquarium on January, 24th, 1929. They thrive quite well and in the second half of April and the beginning of May, 1929, it was discovered that they all had produced young ones. On April 18, a small number of young *A. percula* were discovered in the water near the surface and one single young *A. ephippium* was found in one of the anemones of its tank; on May 5, a young

<sup>1)</sup> In connection with this couple I should like to ask whether assortative mating, said to occur in birds (*Stercorarius*) occurs in fishes. Specimens of *Premnas biaculeatus* with very broad white patches instead of the ordinary bands are rare. Now, this couple showed the remarkable peculiarity that male as well as female showed broader white patches than all other *Premnas* which I got sight of. It is, perhaps, not quite impossible that this peculiarity developed on account of certain properties of the anemone in which both fishes lived. But it is certainly much more probable that the size of the white spots is discriminated by the individuals of this species and that they show a preference for similarly coloured congeners.

Of course assortative mating is known to occur in lower animals: *Paramecium*, the nudibranch *Chromodoris zebra*, the Amphipods *Gammarus locusta* and *Dikergammarus fasciatus*, see CROZIER & SNYDER (1923). But here the question is quite different: it is chiefly due to the fact that the mutual fitting of two individuals, requisite for conjugation or copulation, is mechanically possible only or at least best possible when the sizes of the two individuals stand in a certain relation to each other. In those animals, however, where a definite colour or a certain colour pattern is concerned in the assortment, a psychic factor seems to be the leading one, constituting a point of study of much interest.

Perhaps, however, another possibility is not wholly negligible: that male and female in the above mentioned case were young of one and the same brood, in other words were brother and sister.



*Premnas* was found in the anemone inhabited by its parents. As will appear further on the young fishes in the anemones must have hatched from eggs laid about three weeks before, i.e. about the end of March and medio April or earlier. *A. percula* then went on propagating, one brood following the other, as will be described further on, for several months. *A. ephippium* and *Premnas*, however, gave only two other broods and then ceased breeding. *Premnas* gave (as stated) its first brood probably about medio April or earlier, a second brood appeared on May 6th, a third on June 4th and 5th. *A. ephippium* probably produced its first brood at the end of March, a second brood at the end of April, a third on June 2nd <sup>2)</sup>. It is of much interest that we find here about simultaneous spawning in two species, which suggests that their spawning may have been influenced by external factors.

If these observations give us an idea of the conditions in nature, we may perhaps conclude that the larger *Premnas biaculeatus* and *Amphiprion ephippium* have a distinct breeding period, in which they produce several broods, whereas the small *A. percula* propagates during a large part of the year. Such a difference in breeding behaviour in related species is quite possible. If we restrict ourselves to the neighbourhood of Batavia <sup>2)</sup> we find that the milkfish (bandeng, bango), *Chanos chanos* (FORSK.), as is wellknown, spawns twice a year, viz., during the turning of the monsoons, in March-April and September-November (see, for instance, VAN KAMPEN); whereas Prof. DELSMAN permits me to mention that he found the eggs of two species of the Clupeid genus *Stolephorus* all the year round; as to birds *Prinia inornata* (subsp. *blythi*), *Streptopelia bitorquata* and *Geopelia striata* breed periodically, whereas *Prinia familiaris* and *Streptopelia chinensis* (subsp. *tigrina*) may be found breeding all the year round (SONY, 1926 and 1930); as to crabs I found that *Sesarma taeniolata* probably is a periodical spawner, whereas *S. bataviana* seems to spawn all the year round (VERWEY, 1930b).

Possibly only during that time of the year in which they breed (April-June: shifting of the monsoon) the temperature of the water is high enough to influence the larger damselfishes in this respect, either directly or perhaps indirectly (larger food quantity). More observations, however, are needed before we have sufficient evidence for this opinion.

Mature damselfishes, especially during the breeding period, are very active. Every now and then male and female, in returning to each other after their very short excursions, bite each other in the flank, turn around each other in excitement, etc. In these disputes the larger animal, i.e. the female, takes the initiative, at least in so far as *percula* and *Premnas*, with their large differences in size, are concerned. Very conspicuous behaviour, in which especial-

<sup>1)</sup> Again, in 1930, the same pair of *Amphiprion ephippium* laid eggs in the second half of March, medio April and about medio May, thus showing a second year in which propagation took place during the transition period of the monsoons in spring only. See postscript on p. 348.

<sup>2)</sup> We must do this because geographically distinct countries, with their different climates, may show differences in this respect. So the milkfish, *Chanos chanos*, in the Philippine Islands, according to HERRE & MENDOZA, spawns once only, from the middle of April until at its latest the early part of July, in Java twice a year. SONY states that *Geopelia striata* which in West-Java (Buitenzorg) breeds periodically, in East-Java breeds during a large part of the year.



ly the male indulges, is the biting of the substrate in close proximity of the anemone by the fishes. This habit we might call the symbol of parental care of the brood, as will follow from particulars furtheron.

The observations which now follow nearly all deal with *Amphiprion percula* and now and then only I shall be able to give some notes on the other species. I first mention in chronological order the principal events of the life-history of *A. percula* as these have been observed in the Onrust Aquarium.

- April, 18 — A number of very small young in the water near the surface.  
 „ 24-25 — About 12 young in the anemone, others in the water.  
 „ 30 —  $\pm$  40 young ones, near the surface, hatched at an earlier date. Young of April, 18th, in the anemone.  
 May 2 — The young of April 30 still in the water, about 15 fishes of different sizes (young of April 18) in the anemone.  
 „ 5 — The greater part of the fishes of April, 30th, still swim near the surface, some of them, however, are in the anemone.  
 „ 6 — Many of the fishes of April, 30th, in the anemone, only a small number of them near the surface.  
 „ 7 — All the young have taken shelter in the anemone, there are about 50 in all.  
 „ 9-10 — As on the 7th. Now and again a single young fish hunts in the water above the anemone.  
 June 2 —  $\pm$  10 young ones in the water near the surface.  
 „ 6 — About 4 young ones of June 2 still alive.  
 „ 7 — All the young have disappeared.  
 „ 9 — Eggs with large larvae.  
 „ 10 — Eggs have hatched.  
 „ 23 — Another time eggs with large larvae.  
 „ 24 — Eggs have hatched.  
 „ 27 — Young of June 24 still swim near the surface. About 180 eggs, quite undeveloped, deposited during the night of 26 to 27.  
 July 4 — During the night the eggs have hatched.  
 „ 5 — About 20 young ones alive.  
 „ 9 — All young of July 4 have disappeared. Night of 8/9 the fishes have spawn again. There are about 180-200 eggs.  
 „ 15 — Night 14/15 the young have hatched.  
 „ 19 — All young of July, 15th, have disappeared.  
 „ 20 — During night 19/20 the fishes have spawn. There are about 250-300 eggs.  
 „ 27 — The eggs have hatched.  
 „ 31 — There are eggs again; number unknown.  
 August 7 — The eggs have hatched. There are also a small number of young of July 27, which still swim in the water.  
 „ 9 — Young of July 27 and August 7 still swimming.  
 „ 10 — A number of the young of August 7 and a few young of July 27 are still there. The latter show a white collar at least from August 9 onward.  
 „ 14 — As August 10.  
 „ 15 — Night of 14/15 the fishes have spawn.  
 „ 17 — As 14 and 10.  
 „ 19 — The young of July 27 and August 7 have disappeared.  
 „ 22 — The eggs of August 15 have hatched.



- September 3 — There are eggs, but they may have been there during some days already.
- „ 5 — The young have hatched, so the eggs must have been laid on August 28/29.
- „ 10 — The fishes have spawn (9/10 Sept.).
- „ 18 — There are young, but possibly they have hatched at an earlier date.
- „ 21 — A number of young swim below the surface. These young disappear after some days, except perhaps one single individual.

Now there comes a period of rest, which may have had something to do with changes of the weather during the shifting of the monsoons.

- November 14 — Night 13/14 the fishes have spawn.
- „ 21 — Night 20/21 the eggs have hatched.
- „ 24 — The fishes have spawn (possibly already the night before). A small number of young of Nov. 21 are still alive. There are about 200 eggs.
- „ 25-26 — There are approximately 9 young fishes from the hatch of Nov. 21.
- „ 27 — About 3 young of 21 still alive, swimming in the water.
- „ 28 — All young of Nov. 21 have disappeared.
- „ 30 — The eggs of Nov. 24 have hatched.
- December 2 — A small number of young of Nov. 30 are still alive.
- „ 8 — These young have disappeared.

Through a misunderstanding of the boy, who took care of the aquarium work, the female of this pair on Dec. 2 was captured and together with specimens of *Amphiprion percula* brought to Batavia. On December 8 the mistake was discovered and the female, being recognizable by her large size and dark colour, brought back. This shock, however, effected the animal so strongly, that further spawning did not take place until the end of February.

I have to remark yet that the young ones which went into the anemone during the latter half of April and the first half of May — there could be counted about 44 of them — nearly all disappeared and that in October only two had survived, which had about the same size as the male of the pair which had produced them. Further one young, born probably on September 5, survived. These three young ones, besides their parents, were the only survivors of several thousands of young born in the aquarium at the end of 1929.

I described how the excitement of the damselfishes increases when the brood is coming and that then especially the small male shows a very remarkable behaviour, which I called the symbol of parental care of the brood. It consists of picking or biting the wall of the tank (coral rock) in close proximity of the anemone at a certain place and results in cleaning the latter from algae, other organisms, detritus, etc. The place in question is cleaned for the purpose of depositing the eggs here. These eggs, in two of the instances above about 200, once 250-300, are fastened to the cleaned spot by way of the ligament they possess at one extremity. They form a compact mass on a single level in such a way that the brood consists of a patch of about  $5 \times 3$  cm. The brood in nearly all the eleven cases mentioned was attached at one and the same spot, on the wall of the tank next to the foot of the anemone, at a distance of about 2-5 cm from the latter. Only in one or two



instances the brood was attached to another place, on the opposite side of the anemone. Once the foot of the anemone had placed itself on the eggs.

The eggs were always laid during the night, so that actual spawning has not been observed. DELSMAN (1929) has called attention to the remarkable fact that in most tropical fishes, the propagation of which he had the opportunity to study, spawning takes place at about 10 or 11 o'clock in the night, regardless of the phases of the moon or the time of the year.

Both parents take care of the brood, though the greater part of the work is done by the small male, the female being much more mobile; only every now and then it returns to its brood to wave its pectorals or clean the eggs. In dealing with the courtship behaviour we saw that the female is the wooer, being the most active, whereas the male is the one showing more true "female-ness". During the work of broodcare the female shows little devotion, whereas the male takes care of the eggs very assiduously. Prof. DELSMAN has the kindness to remind me that this is the usual course of events with fishes and amphibians. We moreover have a parallel here with those species of birds in which the female is the larger, and more beautiful than the male, as in *Turnix*, a number of *Limicolae* and some others; with these too the female is active in display and fighting, whereas the male takes care of the brood.

During all the time the eggs are there the male does not leave the anemone and it even remains nearly all the time on that side of the anemone where the eggs are fastened. His work seems to be two-fold: 1. taking care that the anemone hides the eggs, 2. cleaning the eggs and perhaps renewing the water in their neighbourhood. The way in which the anemone is dealt with is the same as that in which anemones in bad condition are treated, which has been described before. It appears that the fishes have it in their power to "direct" the anemone by rubbing against it or biting it, etc. This results into the anemone always covering the eggs, in hanging over them with one side, the tentacles fully hiding the surrounding of the place in question <sup>1)</sup>. The cleaning of the eggs takes place by picking away detritus, organisms, etc. with the mouth. It constitutes a very important part of the parental care of the brood and by this instinct even a large part of the wall surrounding the eggs is cleaned. As soon as there are no longer eggs, as in the end of December 1929, the instinct is no longer at work and the wall around the foot of the anemone is rich in growth of foreign organisms; I lay stress on this because at first I thought that perhaps the anemone, by means of its mucus, could clean the bottom around itself. — Refreshing the water is perhaps the result of a movement of waving of the fins (especially of the pectorals) above the eggs. I mention it here only, however, because it plays a part in the care of the brood of other fishes and not because the movements in question cannot have another result. All these manifestations of care of the brood are shown by the male as well as by the female; as already stated, however, the female in pairing, courtship, etc. is the active partner, whereas the male especially takes care of the eggs.

<sup>1)</sup> See, however, postscript.



The number of broods of the pair of *Amphiprion percula* in the Onrust Aquarium is very great, as may be seen from the following summary.

Date of hatching		Lapse of time between the broods (in days).
April	about 15	— ?
	some days before 30	
May	—	More than a month.
June	2 or earlier	
	10	± 8
	24	14
July	4	10
	15	11
	27	12
August	7	11
	15	8
	22	7
September	5	14
	18	13
October		64
November	21	
	30	9

The summary shows that during both shiftings of the monsoons the fishes ceased spawning and that apparently during the intervening periods, at least during the east monsoon, the broods follow each other very rapidly, their number being 11 in  $3\frac{1}{2}$  months. It remains possible, that the observations during May were too incomplete to justify the assumption that really no brood occurred during that month. In that case no rest would occur during the first shifting of the monsoons. This is, however, very improbable.

The lapse of time between two following broods ranges from 7 to 14 days. As the eggs hatch in 7 days there are never two broods at the same time. Assuming an average of 200 eggs for the size of one brood, the total number of eggs produced during the east monsoon amounts to about 2200 which makes perhaps 5000 eggs a year. This number is large as compared with that of other fishes with pronounced parental care, nevertheless it is small when the further behaviour of the young damselfishes is taken into account.

The eggs hatch in 7 days exactly as could be observed six times. As already set forth the fishes clean them all this time. In all cases they hatched during the night. Their development forms the subject of a special paper by Prof. DELSMAN in the same number of this volume of *Treubia*.

As soon as the larvae are free they rise to the surface water and start a planktonic life. It is quite interesting to see how such planktonic larvae react to the sight of any object which breaks the continuity of the water surface.



Using more exact terms we are accustomed to express that in another way: their reactions are phobic light reactions, i.e. reactions consisting in the retreating of the fishes before any change in the quantity of light in their surroundings. The result is that they always remain at a safe distance from the walls of the basin, the tentacles of the anemones near the water surface, other motionless or moving objects, etc. Such a reaction has been described by BREDER (1929) for *Jenkinsia*.

During this surface life the young damselfishes feed on minute planktonic organisms and of course are eaten largely themselves. What they feed on exactly I do not know; I suppose that the composition of the surface water in the tank may be different from that in the sea, as the tank water is pumped up from somewhat below the sea surface; I therefore did not trouble myself with investigations about the contents of the stomach of the tank fishes.

This planktonic life of the young fishes lasts a varying number of days. Generally it appears to end when they get the white band around their neck. With the fishes which were found on April 30 this happened from about the sixth day onward, the eighth day all having disappeared from the surface water. The young of the brood hatched on July 27 behaved quite differently. They did not leave the surface water after 12 days but on August 7, 9, 10 and even 14 and 17 some of them still lived a free-swimming life just below the surface. This occurred notwithstanding the fact that already on August 7 (or earlier) they had acquired the white neck band and evidently were not slow in their development as compared with the young of April 30. The brood of August 7 was still swimming on August 17. Doubtless the behaviour of the young of July 27 was abnormal; as all young died, we do not know how long they would have remained free-swimming.

I know too little about the rearing of young fishes to venture a suggestion as to the reason of the abnormal behaviour described above. I exclude the possibility that these young feared the larger damselfishes in the anemone and for that reason remained near the surface; for it seems much more probable to me that they allowed themselves to be devoured than that they learned to change their normal instinctive behaviour and learned to avoid the anemone. Apparently their development was normal, as after about 10 days they had acquired the white band behind their head. Perhaps it is possible that some kind of food, necessary to their normal behaviour, failed.

A second point I do not understand, is the question, where the numerous young remained which were born in the aquarium but did not grow up. There are several possibilities. The most probable assumption is, that they found no ideal conditions for their growth, presumably through lack of food or because a certain kind of food was lacking. Even those young, which had reached a fair size, gradually decreased in number, so that of about 44 young present in the beginning, finally only 2 were left. — As long as the fishes were quite small, the male *Premnas*, living in their tank, may have caught some. Mrs. STEINFURTH once or twice believed she saw *Premnas* catching *percula*. — Perhaps the possibility is not to be excluded that the old *percula* themselves ate a number of the young ones; they were, however, never seen to do so. — It may also be that many (especially of the larger young ones) were caught by another animal; there lives, e.g., a burrowing animal in this



tank, probably a large *Alpheus*, which does not leave its holes during the day but may come out at night. — Some young may have died because the low oxygen tension during the night was unfavourable to them. — Be it what it may close observation during the day did not reveal the cause of the disappearance of the young fishes and we will have to await further observations to learn what the cause of their death has been.

We saw that on the appearance of the white band in the neck the young damselfishes, going down to the bottom, begin their search for anemones. The knowledge of this fact is of much value to us as it explains many questions relating to the occurrence of a number of damselfishes of different sizes in one and the same anemone. Where many fishes go down to the bottom and start their search for anemones, and the latter are rare, many young ones may settle in one single anemone. These young during their planktonic life may have come from very different places, near and distant, and there may be many males or many females among them. But moreover they come at different intervals of time and thus the fishes in one anemone may be of very different sizes. I already mentioned the fact that one single specimen of anemone 1 may be inhabited by up to seven or even more *Amphiprion percula* at the same time. They always are of different sizes, there mostly being one large individual and a number of smaller ones, of decreasing, even of very small, size. The large individual is a mature female whereas the smaller ones are mature males or immature individuals. I have found, however, three mature males, without a female, in one and the same host-animal and as an exception one may find two mature females in one host. An explanation of this peculiarity can now easily be given. The young fishes found with mature ones in one and the same anemone are not their own offspring, but may have come from other reefs at a great distance. If an isolated anemone is found by three young damselfishes, all males, it is quite possible that these males remain there a long time, before they resolve to leave the anemone and search for an other one. If then this one contains a female a couple will be formed but it is quite as possible that this anemone already contained a couple or contained another male, so that another search for a female would be necessary. With the larger damselfishes, with their strongly developed instinct of maintaining a territory, it will be very difficult for such wandering specimens to be tolerated in an anemone which is already inhabited by an other individual of their own sex. Moreover these fishes never appear to be more numerous than their anemones. In the small *Amphiprion percula*, however, as already mentioned, the instinct of maintaining a definite territory (their anemone) is less strongly developed, so that with these fishes the perseverance of the one balances that of the other, with the result that in many anemones of this species a number of fishes occur together. The same may hold good for *A. akallopis* and for *polymnus*.

It appears possible that part of these young fishes, which find anemones inhabited already, as long as they are very small, are eaten by the larger fishes already present. I have, however, no observations concerning this point. It may



also be that young fishes, which find anemones inhabited by another species of damselfish, are eaten by the latter whereas their congeners do not devour them. In that case we could understand why the young damselfishes always inhabit the same species of anemone as their parents (compare page 321). It is probable that at least part of the small young fishes willingly or unwillingly is accepted by the older ones of their own kind. These fishes, after having grown up a little, will become too large to be eaten. After they have reached a certain size, they are no longer tolerated by the older animals and driven out. In the aquarium this is not very easy for the parents as the young cannot leave the tank and always return to their anemone, as much as possible during the day, always during the night. As in each of the three tanks of the Onrust Aquarium containing *Amphiprion percula*, *A. ephippium* and *Premnas biaculeatus*, two anemones are present, the young occupy one of them and the parents may restrict themselves more or less to the other. The female of *A. percula* now and then visits the second anemone of her tank and may try to drive out the young there. The couple of *A. ephippium* has one anemone especially for its own, whereas the second one is visited by one of the fishes during a great part of the day; during these visits the young are driven away. Of *Premnas biaculeatus*, which always inhabits both anemones, the young disappeared after they had reached a certain size. There is no doubt that in nature it must be impossible for the young to maintain a place in an anemone inhabited by older animals already. For even in the aquarium, where the young cannot flee, we see how adult *A. ephippium* and *Premnas biaculeatus* keep their anemone free from older young ones. Nevertheless it is quite interesting to see how even the "furious" *ephippium* becomes more or less accustomed to the presence of the young after many idle efforts, and ceases the violent pursuit, only to attempt weak efforts now and then. And we understand how in *A. percula*, with its less pronounced territorializing instinct the perseverance of the young finally leads to their being accepted.

The young orange damselfishes (*percula*), when newly hatched, look grey. They are 4 mm long. After some days they get a reddish pink hue. I already stated that after about 12 days they get their first white band, the one around the neck. They are about 7 mm long then. About a week later they have got their second band; a young which is showing a beginning of it measures 7.5 mm, others which have the second band complete measure 10 mm. After about another week the third white band makes its appearance; the young then measure about 12.5 mm. From this time onward they look, though very small, quite like adult *percula*. They grow up quite rapidly, the largest young ones of the brood of April 18 on May 1st measuring 12.5 mm, on May 10th 16 and on June 10th 25 mm. There is a large variation in the size of the white bands, even on the right and left side of the same animal. — We must bear in mind, however, that all these details were observed on young in the aquarium and that in the sea their growth will be more rapid.

I do not know at what age young *percula* get mature, but one of the young



probably hatched about medio April, pursued and picked away another young (hatched medio September) about medio November. And this same young showed distinct sexual excitement towards the large female of its tank (its own mother) on November 25 or earlier. This awakening of the instinct for maintaining a territory and the appearance of sexual excitement probably shows that sexual maturity was not far off in November, i.e. about 7 months after hatching.

The young of *Amphiprion ephippium*, when newly hatched, look grey, just as young *A. percula*. They are of the same size as the latter (4 mm) and larger than newly hatched *Premnas*. The size of the brood probably is about the same as that of *A. percula* (see postscript). After some time these young too acquire a white band behind the head, whereas their groundcolour becomes greyishred (in a young of 6 mm, which still swims near the surface, the white band is still missing). It takes some time before a second white spot appears on the back, just behind the middle. This spot does not remain very long; it disappears after perhaps two weeks. The white band behind the head remains much longer; in forward young it disappears about two months after hatching, but very gradually, first becoming broken here and there, and finally disappearing altogether. A young which I caught at the Haarlem reef on March 1st, 1930, and which shows the last remains of it, measures 55 mm. In backward young ones, however, the band may remain many months, in one of the young in the Onrust Aquarium, born in the first half of April, 1929, which, probably through lack of sufficient food, remained very small, the white band still was present in May, 1930. Before the white band has disappeared, the black colour on the back may have made its appearance. When it has become distinct the moment has arrived, at which the fish — though not at all fullgrown — is beginning to mature. For one of the two young of Onrust, probably hatched in the end of March, which acquired its black colour from November onward, was then seen to pursue and bite away the other (backward) young, mentioned above, which then still had its white band behind the head.

The young of *Premnas biaculeatus* on hatching are smaller and perhaps somewhat darker than those of *Amphiprion percula* and *ephippium*. They measure only 3.5 mm. The size of the brood, in accordance with the smaller size of the young on hatching, seems to be larger than in the two other species. The broods, hatched on May 6th and June 5th, at least, both consisted of many hundreds, perhaps even some thousands of individuals, whereas the broods of *percula* and *ephippium* (one brood, see p. 348) gave rise to 200-300 young only. — These young *Premnas* first get a white band around the neck, which is followed by the other bands, as in *Amphiprion percula*. The ground colour of these young ones soon becomes cherryred, like that of their parents.

The most interesting point of the particulars given above is certainly that the colour patterns of the young of all three species pass through the same stages of development, though their parents are coloured quite differently. *Amphiprion ephippium*, though without a white band when fullgrown, first gets one,



then the indication of a second band, finally loses both again. This may serve to prove the close relation between the species here treated.

N.B. As already stated in the footnote on page 339, *Amphiprion ephippium* in 1930 laid eggs at the same time as in 1929 (see page 339, small type), viz., about 20 March, about 18 April and about medio May. This time the brood was found and the behaviour of the fishes studied. The brood was fastened, just as in *A. percula*, to the wall of the tank not far from the foot of the anemone, under a large piece of coral. It probably consisted of about 300 eggs. One of the fishes assiduously cleaned the eggs, whereas the other did not seem to take any notice of them. As *ephippium* shows no sexual difference in appearance, we can only assume that, as with *percula*, it is chiefly the male which takes care of the brood. — The time of hatching remained unknown, the young disappeared without having been seen. These observations are a further confirmation of my supposition that propagation in all damselfishes goes on in the same way.

On April, 24th, 1930, I found on the Haarlem reef a couple of *Amphiprion polymnus* in a large specimen of anemone 2. The anemone also contained a small young of *polymnus*. This couple of *polymnus* has been the only one in nature, the brood of which I have detected. Though the eggs themselves were invisible to me, the behaviour of the fishes left no doubt as to the point in question. The anemone was attached to a dead colony of *Porites*, which I had known quite well for many months, as the anemone and its two *polymnus* were encountered by me during each visit round the edge of the reef. Below, this rock of *Porites* showed a small hole. And before this hole, at some distance from the anemone, one of the two fishes was busily engaged "picking" the wall, the typical movement of cleaning the eggs. It did this quite assiduously, nearly uninterruptedly. As the other fish did not assist in this work, I assume that, as with *percula*, it is here also the male which chiefly takes care of the brood.

These observations are a further confirmation of my supposition that propagation in all damselfishes goes on in the same way.

#### SUMMARY.

1. Five species of damselfishes occur in the Bay of Batavia: *Premnas biaculeatus* (BLOCH), *Amphiprion ephippium* (BLOCH), *A. polymnus* (L.), *A. percula* (LACÉPÈDE), *A. akallopisus* BLEEKER.

2. They live associated with five or six species of sea anemones.

3. (p. 309-317)). These anemones have each very special ecological wants, anemone 1 inhabiting lagoons or shallow water only, no. 2 preferring coral growth in clear water, up to a depth of 6 metres or more, no. 3 open patches of sand or dead coral from shallow to deeper water (7 m), but never occurring in lagoons, no. 4 preferring coral or coralrocks in clear water up to a depth of 8 metres or more, no. 5 finally living in holes or deep crevices in or between coralrocks. All these anemones are diurnal and bear large numbers of zoöxanthellae. For particulars on their reproduction and young see pages 316-317.



4. The anemones are associated with the fishes in the following way:  
 anemone 1 is inhabited by *Amphiprion percula* (LACÉP.),  
 „ 2 *A. polymnus* (L.),  
 „ 3 *A. ephippium* (BLOCH) (especially when young) and  
*A. polymnus* (L.),  
 „ 4 *A. percula* (LACÉP.) and  
*A. akallopisus* BLEEKER,  
 „ 5 *A. ephippium* (BLOCH) and  
*Premnas biaculeatus* (BLOCH).

Thus:

*Amphiprion percula* (LACÉP.) inhabits anemone 1 and 4.

„ *akallopisus* BLEEKER „ „ 4.  
 „ *polymnus* (L.) „ „ 2 and 3.  
 „ *ephippium* (BLOCH) „ „ 5 and, especially when young,  
 „ 3; once anemone 2.  
*Premnas biaculeatus* (BLOCH) „ „ 5 only.

5. As the ecological wants of the fishes do not wholly agree with those of the anemones, the anemones may sometimes be found without fishes; the fishes, however, never occur without their anemone.

6. (p. 317-322). The preference of the fishes for distinct species of anemones seems to be chiefly based on the size of the anemone, the size of its tentacles and its ecological wants. Under aquarium conditions the fishes content themselves with several of the species of anemones, so that the association cannot be based upon the chemical properties (poison) of the anemone alone. *Premnas*, however, only accepts anemone 5. — The anemone may be recognized by the fishes from its appearance alone. — One is lead to the assumption that the association grew from a general to a more specialized one and that the preference of the fish for a certain anemone became inherited. It must, at least, be instinctively fixed.

7. (p. 322-332). The fishes cannot live without their anemones in nature, as they are protected by them against fishes of prey. In general there is no more than one couple of fishes in one anemone or group of anemones, as the instinct for maintaining a certain territory is strongly developed in damselfishes. The fishes feed on plankton. They also feed on their anemones. At least three of the species bring food to their anemones. Food rejected by the anemone as well as the waste matter of the latter may be carried away or eaten by the fishes. Especially anemones in bad condition are "treated" by the fishes, which rubb them and wave their pectorals. — There is a great difference in the behaviour of the five species of damselfishes in the above particulars: the closest association is that between *Premnas* and anemone 5. Here we are dealing with true symbiosis in the sense of mutualism.

8. (p. 332-337). In comparing other cases of symbiosis, especially that between anemones and hermit crabs, with the one under consideration, we find close resemblance in the nature of the symbiosis. The association with anemones



of both damselfishes and hermit crabs is based on the same "principles". The closeness of the association differs as much among the different species of hermit crabs and their anemones as it differs among the species of damselfishes.

9. (p. 337-348). In *Premnas biaculeatus* and *Amphiprion percula* there is an important sexual difference in size, the female being the larger. Propagation in *Premnas* and *A. ephippium* seems to be restricted to a certain period of the year, whereas *A. percula* propagates nearly the whole year round. The eggs (of *percua* and *ephippium*) were in all cases fastened to the aquariumwall (coralrock) in close neighbourhood of the anemone. One brood consists of about 200-300 eggs. Whereas the female is the most active one in courtship, the male especially cares for the brood, which is continually cleaned. — *A. percula* produced 11 broods in 3½ months, which would perhaps make about 5000 eggs a year. — The eggs of *percua* hatch in 7 days. The lapse of time between two broods ranged from 7-14 days, so that there were never two broods at a time. — When the larvae of *percua* are free they rise to the surface and start a planktonic life. This lasts perhaps 12 days maximally and is followed by a seeking of the bottom, where the young fishes begin their search for anemones. Young fishes found with old ones together are not their offspring, but may have come from other reefs. After these young have reached a certain size, they are driven out by the older animals. — For description of the young of *Premnas biaculeatus*, *Amphiprion ephippium* and *A. percula* see p. 346-348.

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<sup>1)</sup> All papers indicated with an asterisk were not to be got in Batavia and were only seen as abstracts or cited by others.

For a more complete summary of the literature on the symbiosis between sea anemones and hermit crabs see COWLES and others.



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Postscript (p. 309-310): After this paper was finished I found the following facts of interest in GRABAU, Principles of Stratigraphy, New York, 1924, p. 218. "Measurements made in Lake Ontario showed that stirring of the sand at the bottom by storm waves does not extend down to 20 feet. Four empty boxes were anchored in the sloping sand bed of the lake bottom "at equal distances over a length of 650 yards, in depths of 6 feet, 12 feet, 18 feet and 20 feet. After storms it was found that the first box in the shallow water became filled with sand; the box in 12 feet of water half-full; in the one at 18 feet there was little sand; and at 20 feet there was no sand in the box" " (cited after WHEELER, The Sea Coast, London, 1902, p. 73).

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Plate XV Fig. 1. Specimen of anemone 3, fully expanded.

- " 2. " " " 1. " " . Note the folds in the oral disc.
- " 3. On the foreground a specimen of anemone 5, the columnwall of which is hidden below a piece of dead coral. On the background a specimen of anemone 4, expanded.
- " 4. The same specimen of anemone 3 as in fig. 1.
- " 5. In the middle of the foreground a colony of the coral *Actinotryx*. To its left and right specimens of anemone 1. On the background, to the right, a specimen of anemone 2, to the left two specimens of anemone 4. — The specimens of anemone 1 and 2 are not fully expanded, note the many folds in the oral discs.

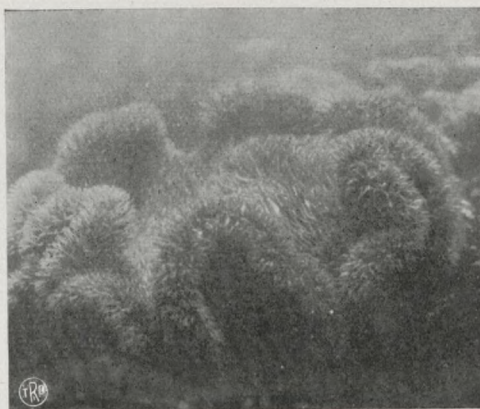
Photographs by BOSCHMA were made January, 1930, by VERWEY April, 1930.





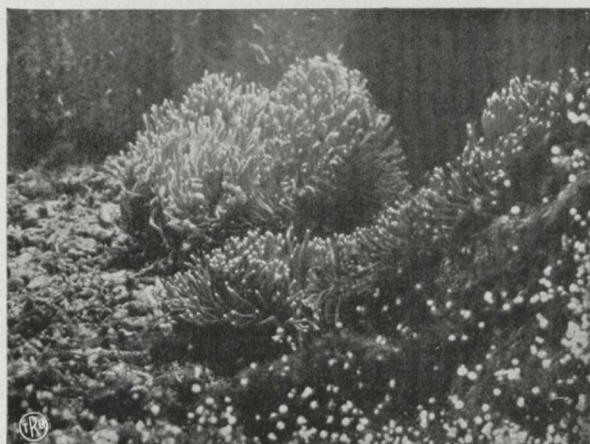
BOSCHMA photo.

1



VERWEY photo.

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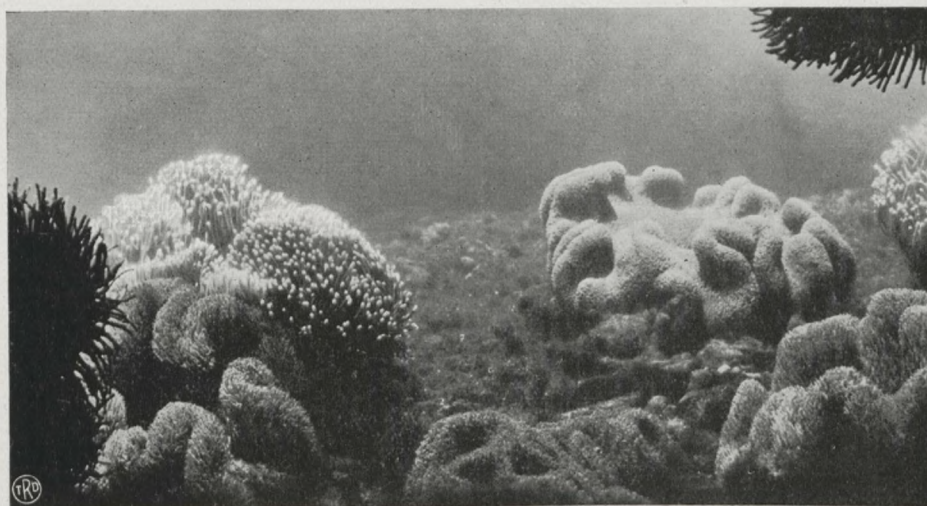
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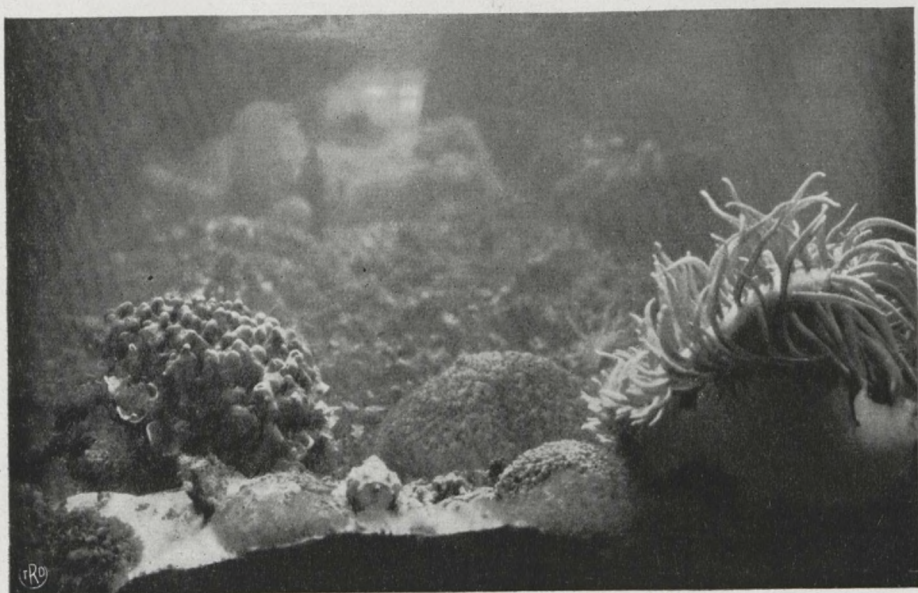


Plate XVI Fig. 6. and 7. Tank 5 of the Onrust Aquarium.

To the left a colony of *Heliopora coerulea*, from the lagoon of Hoorn, living in the aquarium for about 14 months. To the right a specimen of anemone 3. Between them, in the middle, *Herpetholitha*. In fig. 7, between *Herpetholitha* and anemone 3, a colony of *Euphyllia* (right) and a young anemone, about one year old (left). In the foreground from left to right specimens of *Fungia fungites*, the fish *Scorpaenopsis* and the coral *Polyphyllia*, the last named with expanded tentacles. They are not well visible because the glass of the tank is not quite clean below. On the background, to the left, a large, beautiful specimen of anemone 2. The bottom of the tank is covered with dead coral fragments, overgrown with algae, especially *Padina*. Photographs were made April, 1930.

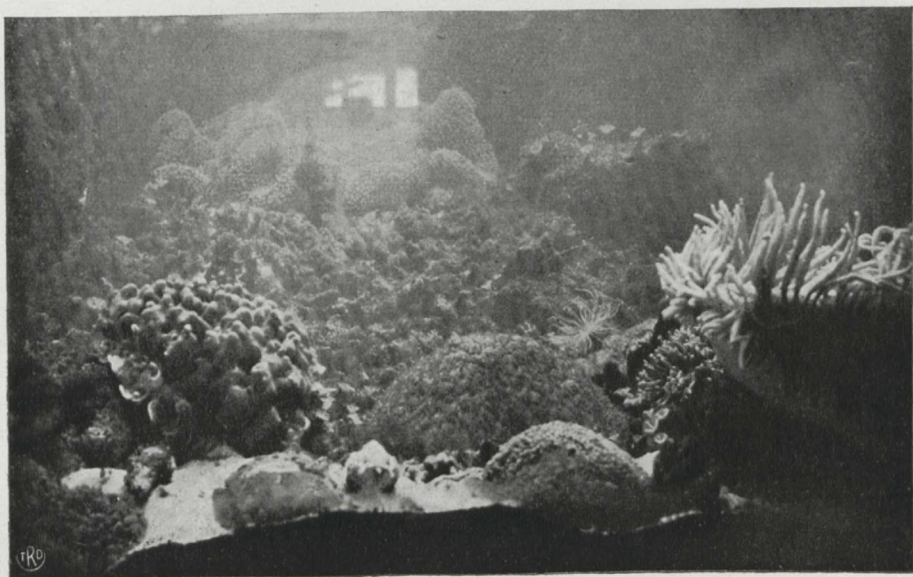
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VERWEY photo.

6



VERWEY photo.

7







## Appendix: Sexual, individual, local and geographical Variation and Colour Change with Age in Damselfishes.

Colour descriptions of damselfishes, made from living material, are not numerous. Yet they are worth being recorded in detail, because the slight differences in local variation should be described, if we wish to get a chance to understand their development. Moreover some of the species give us instances of fishes the young of which have a different colouring from their parents, as is the case in not a few others forms inhabiting East-Indian reefs, e.g. species of the genera *Scolopsis*, *Diagramma*, *Therapon*, *Lutianus*, *Platax*, *Pomacentrus* and others. I therefore give a short description of the colour of the five species of damselfishes inhabiting the Bay of Batavia, at the same time adding some measurements which show that at least two of the species exhibit an important sexual difference in size. — My study of the literature was not very thorough. Of the papers cited, especially those of MONTALBAN and FOWLER and BEAN, giving full colour descriptions of living animals, are quite valuable.

Among the literature cited one finds a paper by WHITLEY on "Some Fishes of the Order Amphiprioniformes". It contains an exact summary of original, especially Australian literature. As it brings us back, however, to the time of GÜNTHER, it deserves special mention here. Whereas I myself (see below) come to the conclusion that the whole of the Indo-Australian region possesses 6 or 7 species of damselfishes only, WHITLEY recognizes no less than 14 for Australia, and probably many more for the whole of the Indo-Australian region. Of course, one thinks, WHITLEY must be right and I must be wrong; for his paper is based on a very thorough knowledge of the older literature and I myself did not even take the trouble to study the original literature directly bearing on the subject. Nevertheless I venture to criticize WHITLEY's paper. — It is quite possible that WHITLEY is right in his statement that the name *bifasciatus* (BLOCH) is preoccupied by *unimaculatus* MEUSCHEN. It is a question of taste to follow FOWLER in placing *percula* in the separate genus *Actinicola*. But the systematist of to-day has no longer the right to describe or recognize a number of so called good species when these animals do not show quite distinct differences from the ones already recognized. WHITLEY himself knows the reefs quite well and for that reason should have taken the trouble to study variation in living animals first, in order to understand the range of variation of the animals, the type specimens of which he wished to study. For the systematist of to-day "has learned that consistency alone is the real test of the systematic worth of a character" (HUBBS). My remarks may hold good for a number of other systematists; few of them, however, have the opportunity WHITLEY has, to go out to coral reefs, to seek the living animals himself. Some instances may follow.

*Amphiprion papuensis* MACLEAY 1883, according to WHITLEY, is a good species, recognizable from "several others from the Pacific region" by the coloration of the fins, the width of the bands, the concave caudal margin and the scale counts. If one knows the very large variability in colour, width of bands and form of caudal in *Amphiprion polymnus*, however, one wonders how anyone dares recognize such a species. The only difference in fin colour between *papuensis* and *polymnus* would be that the soft dorsal is whitish instead of dark. Tail form and width of bands are quite variable in *polymnus*. And the number of scales does not differ from that of *polymnus* at all.



*Amphiprion mccullochi* is described as new. "In *Amphiprion melanopus* BLEEKER, with which *mccullochi* has been confused, the dorsal is yellowish, not black, and the opercular band extends to the top of the nape". Such a character, consisting of small colour differences, is, however, of no value. Moreover MONTALBAN in 1927 already united *melanopus*, *macrostoma*, *ephippium* and *polylepis* with *frenatus* BREVOORT, and FOWLER 1928 remarked: "Our materials show variations corresponding very well with *Prochilus macrostoma*, *Prochilus polylepis*, and *Prochilus melanopus* of BLEEKER's Atlas. Besides these we have other quite variable conditions of colour". Why does WHITLEY neglect such remarks?

*Actinicola bicolor* (CASTELNAU): "Very closely allied to *Actinicola percula* (LACÉPÈDE), but with eleven dorsal spines and the face, ventrals and areas between the cross-bands uniformly dark". BLEEKER, however, already considered *bicolor* a synonym for *percula* and remarked for the latter: "D  $11\frac{1}{15}$  vel  $11\frac{1}{16}$ ". MONTALBAN says about *percula*: "Dorsal XI, 15 or 16", FOWLER: "D X or XI, 14 I to 17 I". And as to the uniformly dark colour it may suffice to state that two of WHITLEY's four specimens date from 1879 and that MONTALBAN remarks for *percula*: "Color in alcohol ranges from light yellowish brown to dark brown".

There is no doubt that many names in WHITLEY's Check-list in the same way do not stand a sound criticism. For *Amphiprion melanopus* BLEEKER see below. *A. bicinctus* RÜPP. and *milii* BORY have for a long time been considered synonyms of *polymnus* (L.); *tricolor* GÜNTH. has been considered a synonym for *ephippium* (BLOCH) by BLEEKER and MONTALBAN. *A. melanostolus* and *rubrocinctus* RICHARDSON, as well as *Premnas gibbosus* CASTELNAU in the same way are certainly mere synonyms only. I refrain from going into further details, but wonder of what use this Check-list will be, if many more species are recognized on such slight differences of structure and colour, which fall within the normal variation of other species. It is a great pity WHITLEY seems not to have seen MONTALBAN's valuable paper.

Finally be it remarked once more that my annoyance is not directed towards the thoroughness of the work itself which is perhaps far greater than that of my own, but towards the method of working which is false. When a systematist can get an opportunity for taking into account the knowledge of living animals, he is to be blamed when he neglects it.

#### *Premnas biaculeatus* (BLOCH).

Colour description and sexual difference. Groundcolour a darker or lighter cherry to brownish red all over the body and fins. The body is crossed by three transverse pearlwhite bands, which are wider superiorly and which may be edged narrowly by black. The first one is convex posteriorly, crossing over the hind portion of the head and the subopercles; the second descending from the last dorsal spines to the origin of the anal fin; the third around the caudal peduncle.

The males are always much smaller than the females, their maximal size being about 110, that of the females 156 mm <sup>1)</sup> or somewhat more. There are, however, couples, in which the female is more than thrice as large as the male; nevertheless the males in these couples are sexually mature, as is shown by the presence of ripe sperm. — As a rule the males are lighter coloured than the females, they often being cherry red, whereas the females are mostly of a

<sup>1)</sup> BLEEKER gives 145 mm as the maximum size for 21 specimens. I measured up to 156 mm and saw large females, which surely reached 160 or more.



dark, sometimes even very dark, nearly black, brownish red. The white bands in the males are mostly wider than in the females, especially as the latter become fullgrown.

**Individual variation.** As is wellknown there is great individual variation. GÜNTHER recognized four, BLEEKER three colour varieties, WEBER described two more of them. I believe it is of little use to burden literature with their names, as they are linked up gradually by intermediate types of coloration. WEBER rightly remarked: "Die Bänderung ist aber so variabel, dass bereits die wenigen mir vorliegenden Exemplare die Grenzen der Varietäten überschreiten und diese somit überbrücken". The chief point of interest is that the variability concerns chiefly the extent of the white bands, which are mostly very distinct in males and may become quite indistinct or fail in females. But on the other hand there are old females with very large blotches of white and there are males with very little white. — Variation may show itself also in the fins, which may be edged with black, but this, I believe, is of rare occurrence in animals from the Bay of Batavia.

**Local variation.** Local variation shows itself where fishes from the southwestern corner of the Bay, especially from Onrust, are compared with fishes from more northern islands, in this case the Thousand Islands proper. The fishes from the neighbourhood of Onrust are nearly all quite dark, most of the males showing a distinct cherry red, the females a darkbrownish or even blackish red. If on the other hand one takes the fishes from Dapur, they are of a brighter red, the males mostly being of a bright cherry red.

**Colourchange with age.** The young of *Premnas biaculeatus* are grey when newly hatched, 3.5 mm long. They first get a white band around the neck, which is followed by the second and third band probably from two to three weeks or more after hatching. The groundcolour of these young fishes soon becomes of a more or less cherry red, like that of most adult male *Premnas* from the Bay.

#### *Amphiprion percula* (LACÉPÈDE).

**Colour description and sexual difference.** Fishes from Onrust have the upperparts and flanks orangebrown, darkest above, becoming lighter, nearly orange, below. The body is crossed by three tranverse pearl white bands, edged with black. The first of them crosses the posterior part of the head and the opercles, the second one connects the posterior dorsal spines or (and) forepart of the soft dorsal with the vent between ventrals and anal, the third one covers the caudal peduncle. The middle band is angularly pointed in front, and slightly concave behind. All fins, except the spinous dorsal and the ventral, bear a white terminal and a black subterminal band; spinous dorsal and ventral have a black edge only, though sometimes also a very narrow white edge.

As in *Premnas* there is a rather important sexual difference in size, the maximum length for 12 large males and 13 large females (all sexed) being 60



and 77 mm respectively. One may find couples in which the female is nearly twice as large as the male, males of 35-40 mm possessing ripe sperm already.

Individual variation is great. It chiefly concerns the extent of white and black of the margins of the fins. In many specimens the black fails altogether, except on the ventrals, in others it may be very conspicuous; in the same way the white edges may be very wide or quite narrow. There is a slight variation in the orange ground colour.

Local variation. Fishes from Dapur are perhaps somewhat less brown, more orange, than fishes from Onrust, this difference being small, however.

Colour change with age was studied in detail in this species. When newly hatched, young orange damselfishes — then measuring 4 mm — look grey. After some days they get a reddish pink hue. After about 12 days they get their first white band, the one around the hind portion of the head. They are about 7 mm long then. About a week later they have got their second band. They measure 7.5-10 mm then. After about another week the third white band makes its appearance; the young then measure about 12.5 mm. These notes relate to fishes in the Onrust Aquarium; in the sea their growth may be more rapid.

#### *Amphiprion polymnus* (LINNAEUS).

Colour description and sexual difference. The specimens of *polymnus* from the Bay of Batavia are generally coloured as follows. Whole body, with the exception of the white bands and the snout, jetblack, this colour sometimes grading to a brownish black or brownish on the under part of the breast and chin, between the mandibles and the ventral fins. The snout, i.e. the fore part of the head before the eyes and round the mouth, is coloured about cinnamonbrown or yellowishbrown. The fish is crossed by three transverse white bands. The first covers the sides of the head and the foremost half of the opercles, and extends to the underedge of the preopercles. The second begins at the base of the last dorsal spines and ventrally meets the other half just before the anal fins. The third one covers the base of the caudal peduncle. The whole dorsal fin (except the superior part of the median white band), the base of the pectorals, the ventrals and the anal fin are black like the body. The rest of the pectorals and the caudal are yellow, orange yellow or orange. These fishes from Batavia were originally described by BLEEKER (1863, p. 480) as *Amphiprion xanthurus*.

Sexual difference, if it exists, must be very small. I saw several couples, in which male and female, both large, were of about the same size. BLEEKER gives 136 mm as the maximum size for 38 specimens. I measured up to 122 mm.

Individual variation is very important. BLEEKER already recognized four varieties in the colour of the fins. He does not say whether he was dealing with local or individual variation, but we may be sure he was dealing



with both. Whereas he originally described the black fishes from Batavia as *xanthurus* his general colour description, given 22 years later in his List of the Pomacentrids of the East Indies, reads as follows: "Colore corpore antice aurantiaco, medio et postice fusco vel nigricante-fusco". He does not refer to the wholly black *xanthurus* with a single word there. — If we restrict ourselves to fishes of the Bay, a fish agreeing with BLEEKER's later description is very rare; as has been stated twice nearly all fishes from the Bay are black. Nevertheless such specimens as later described by BLEEKER do occur, as on the reef of Haarlem, where *polymnus* is more common than on the other reefs in the neighbourhood, I caught one specimen (24 III, 1930) which has the forepart of the head (between and before the eyes), chin and breast, including the pectorals and ventrals, posteriorly and ventrally up to the second white band, beautifully orange; the tail is yellow, the dorsal black, the rest of the body jetblack with the three bands as in other specimens from the Bay. — As to other colour varieties SLUITER already remarked: "Ich fand aber zuweilen Exemplare, wobei die drei silberweissen Querbänder mehr gelblich waren, indem auch die Farbe der Schwanz-, After- und Bauchflossen zwischen Schwarz und Gelb variierte". I myself once (24 III '30, Haarlem) saw a specimen which answered to the description of *polymnus* from the Bay, but the tail of which was black, with the exception of a little yellow at the base, directly behind the white band round the caudal peduncle. And in another specimen (5 III '30, Edam) the third white band around the caudal peduncle failed altogether. Both these specimens formed a couple with normal ones.

**Local variation.** Fishes from Dapur and Klein Kombuis differ somewhat from those from the Bay (especially from those of Haarlem). Their snout is yellow instead of brown. Even fishes from Edam seemed to me to have a more yellow snout than the ones from Haarlem. This, however, seems to be the only difference.

**Colour change with age.** The youngest specimens from the Bay and Thousand Islands I got sight of measured about 12 mm in length. They already had developed the black colour and the three white bands, but differ markedly from adults in that they show much more white and yellow. Two young from Enkhuizen, 28 III '30: Snout, spinous dorsal, pectorals, ventrals, anal and caudal are for their greatest part of a very pure yellow. The second white band extends over the anterior and upper margin of the soft dorsal, and the third band around the caudal peduncle extends along the upper edge of the caudal and fringes the yellow tail. A young from Dapur, 6 III '30: Snout, tail, and the distal part of all fins all of the same pure yellow, white second band continuing on soft dorsal.

When these small young grow older, they lose part of their yellow and white, whereas the black extends more and more. First the yellow disappears on dorsal, anal and ventrals, then the white also disappears. A young of 45 mm has the tips of the fins still yellow, the rest of the fins (I refer to soft dorsal, anal and ventral, as pectorals and caudal remain yellow) jet-black already.



It takes a longer time before the white colour of the second band retires from the edge of the soft dorsal. This takes place when the fishes reach a size of about 9 cm, as was proved by a specimen growing up in the public aquarium at Batavia. A specimen of about 78 mm still shows the white on the soft dorsal. At the same time the tail, which is rounded in young specimens, becomes truncated and finally furcated.

I treat this change from young to old so much in detail because I believe that BLEEKER's *Amphiprion sebae* refers to the young of *A. polymnus* and is not a distinct species. The only places from where this species was known to BLEEKER were Nias, Lampong, Siboga (Sumatra) and Batavia. Whereas it may appear already somewhat improbable that BLEEKER got specimens of a real *sebae* from Batavia, where the reefs have been studied so thoroughly now without *sebae* having been found, BLEEKER gives no characteristics on which this species is to be based. According to BLEEKER's description *sebae* and *polymnus* differ in the following characteristics.

	<i>sebae.</i>	<i>polymnus.</i>
dorsalfin	notched, last spines much shorter than median ones; figure shows the soft dorsal longer than the spinous; DAY says: soft dorsal longer than spinous.	last spines about as long as median ones; soft dorsal not much longer than spinous.
caudal	truncated	forked, with pointed angles.
scales	about 55 rows above, 45 below the lateral line.	50 and 45 rows resp.
colour	two white bands, the second extending on the soft dorsal; anterior part of the body not orange.	three white bands, the second not on the soft dorsal; anterior part of the body orange and other colour differences.

BLEEKER gives as maximum size for *sebae* 110, for *polymnus* 136 mm.

All these characteristics are applicable to young *polymnus*. The dorsal fin is more notched in young than in old *polymnus* and especially the soft dorsal (as well as the anal) in young animals is much higher than the spinous one. We find the same in other fishes, an extreme case of this kind is to be found in the species of the genus *Platax*. — The young of *polymnus* have the caudal truncated, not forked. — According to BLEEKER *sebae* has about 55 rows of scales above the lateral line instead of 50 (as in *polymnus*); but I possess a specimen of *Amphiprion* which agrees wholly with BLEEKER's description of *sebae* and which has 50 rows only. Moreover BLEEKER says that his *sebae* is extremely closely related to *bifasciatus*, but the latter has also 50 rows only.



And in the figure he gives of *sebae* (Atl. Ichth., Tab. 400, fig. 9) there are to be counted about 50 rows and not 55. — As to the colour I already remarked that I saw a typical *polymnus* without the third band and that *polymnus* in the Bay rarely shows the anterior part of the body orange. As to the further colour difference, the collection of our laboratory possesses some specimens of *Amphiprion*, which agree with the one figured by BLEEKER as *sebae*; but I should hesitate to refer them to another species than *polymnus* as I should not know on what to base the identification.

BLEEKER got his *sebae* among others from Batavia where *polymnus* is coloured differently from *polymnus* from other places. He says that it is also known from the Andamans. This surely refers to DAY's statement in this "Fishes of India". DAY says he captured two specimens of equal size, and it follows from the picture these were about 95 mm, so that, being not yet fullgrown, they may have had the characteristics of young animals.

N.B. FOWLER, in The Fishes of Oceania, mentions *bicinctus* RÜPP. as distinct from *polymnus*, but in describing the Albatross-material FOWLER and BEAN mention it as a synonym of *polymnus*.

#### *Amphiprion ephippium* (BLOCH).

Colour description and sexual difference. Most fishes from Onrust have the whole body brownorangered, darkest on the flanks, lightest on the head. All fins orangered. Anterior margin of ventrals black. There occur also specimens, however, which are coloured much lighter.

I could not find any sexual difference, there being many couples in which both fishes are of the same size. BLEEKER gives 120 mm as the maximum size for 14 specimens, I measured up to 116.

Individual variation is small, consisting in darker or lighter groundcolour and extent of the black.

Local variation. Fishes from Dapur and Klein Kombuis as a whole are more beautiful than those from Onrust. Most fishes from Dapur are of a nearly uniform orangered (brownish on head and forepart of back) whereas the flanks bear in their posterior half a distinctly circumscribed black patch, which contrasts quite strongly with the orangered body. At Edam there are fishes quite as bright as those from Dapur, but there are others, which look more like dark fishes from Onrust, though the majority may be brighter than at Onrust.

Geographical variation. As will follow from particulars given below young *ephippium*, up to about two months after hatching, bear a narrow white band around the posterior part of the head. In fishes from the Bay or the Thousand Islands this band never remains after the fishes have matured. BLEEKER in his paper on the Pomacentrids rightly treated these animals (*frenatus* DAY or *tricolor* GÜNTL., according to BLEEKER — see below — not *frenatus* BREVOORT!) as young of *ephippium*, his largest specimen measuring 86 mm.



DAY wrote "Although I have placed this fish as distinct from *A. ephippium*, it seems not unlikely that it is merely a variety. Among the fishes I took at the Andamans were several of the young having the white ocular band, whilst all the adults were without it, being *A. ephippium*. Since then I have seen several adults with the light band, but I am not sure whether such may not be the livery of the immature retained in the adult stage". This may have led BLEEKER to his above quoted statement, as on the plate in Atl. Ichthyol. the fish still bears the name *frenatus*, whereas in his paper he called it *ephippium*. Now it is interesting to learn from FOWLER and BEAN and from MONTALBAN's paper that all the examples of this fish they examined from the Philippines bear the pearl white transverse band on each side of the head. This leads them to place this species as distinct from *Amphiprion ephippium*. We are dealing with a quite interesting fact here. For, taking into account the colour of young *ephippium* and the variability of DAY's material, we may perhaps assume that FOWLER & BEAN and MONTALBAN are dealing with true *ephippium*, a species which would fail in the Philippines if there existed a real *A. frenatus*. We would have the remarkable fact then that *ephippium* in Batavia does not, in the Andamans does sometimes, and in the Philippines does always retain characteristics of its youth; the same would hold for the fishes described by BLEEKER under the names *polylepis*, *macrostoma* and *melanopus*, see below.

Colour change with age. The young of *Amphiprion ephippium*, when newly hatched, look grey, just as young *A. percula*. They are of the same size as the latter (4 mm) and longer than newly hatched *Premnas*. After some time these young acquire a white band behind the head, whereas their ground-colour becomes greyishred (in a young of 6 mm, which still swims near the surface, the white band is still absent). It takes some time before a second white spot appears on the back, just behind the middle. This spot does not remain very long; it disappears after perhaps two weeks. The white band behind the head remains much longer; in forward young it disappears about two months after hatching, but very gradually, first becoming broken here and there, and finally disappearing altogether. A young of the Haarlem reef, March 1st, 1930, which shows the last remains of it, measures 55 mm. In backward young the band may remain much longer. — Before the white band disappears, the black colour on the back may have made its appearance.

N.B. WEBER treated *A. macrostoma* as a synonym of *melanopus*. FOWLER, in the Fishes of Oceania, mentions *polylepis* and *melanopus* as distinct. But FOWLER and BEAN remark on *polylepis*: "Our materials show variations corresponding very well with *Prochilus macrostoma*, *Prochilus polylepis* and *Prochilus melanopus* of BLEEKER's Atlas." MONTALBAN treats *polylepis*, *macrostoma* and *melanopus* BLEEKER as synonyms of *frenatus* BREVOORT. If I am right in my assumption that *frenatus* is only an *ephippium* in which the band of the young remained during life, then *polylepis*, *macrostoma*, *melanopus* and *frenatus* disappear all. The question of synonymy is made still more complex by BLEEKER's statement that *frenatus* DAY is a young *ephippium*, whereas the original *frenatus* BREVOORT



possibly is a good species. MONTALBAN, however, puts them as synonyms and I eagerly follow him in this, as according to BLEEKER the drawing of BREVOORT is too bad to support such a view.

*Amphiprion akallopis* BLEEKER.

Colour description and sexual difference. Body brown-pinkish, but undersurface, including pectorals, ventral and anal, yellow. A median dorsal stripe from nostrils to base of caudal purely white, narrow on the head, broad along the back. Dorsal fin and tail greyish white.

BLEEKER gives 95 mm as the maximal size for 8 specimens. I measured 6 mature specimens, the largest of which was 73 mm. But I did not succeed in catching large individuals.

In so far as I can judge from observations on the reef male and female reach about the same maximal size or differ very little, though generally the male may be somewhat smaller than the female. There are couples, however, in which one sex is much the smaller.

Individual variation. This species, though very common at Dapur, is rather rare in the Bay of Batavia, where I found it at Schiedam, Haarlem and Edam. The reason for this probably is that it needs clear water. I therefore do not know whether it inclines to local variation or not. I do not believe there is a difference in the colour of specimens from Haarlem and Dapur.

Colour change with age. I do not know the very small young of this species. Specimens of *Amphiprion*, agreeing with *akallopis*, but bearing a nucho-subopercular band, have been described by BLEEKER as *perideraion* and *rosenbergii*. BLEEKER himself remarks on *rosenbergii* that it may be a young *perideraion*. From the description of the latter follows, however, that it should not be impossible that *perideraion* is nothing but a young *akallopis*. We would have the same problem as mentioned under *A. ephippium*: there would be places where the mature animals retain characteristics of their youth. This question will be solved as soon as the small young of *akallopis* have been found. If really *rosenbergii*, *perideraion* and *akallopis* represent one species, we must call the latter *perideraion*.

*General conclusions.*

The above quoted observations lead us to the following points of somewhat more general interest.

1. Two of the five species of damselfishes from the Bay of Batavia, *Premnas biaculeatus* and *Amphiprion percula*, show an important sexual difference in size, the male being much smaller than the female. In *Premnas* moreover the males are generally coloured lighter than the large females. — The other three species treated probably show no or very little difference in the two sexes.
2. There is great individual variation in *Premnas biaculeatus* and *Amphiprion percula* and *polymnus*.



3. Fishes from the Bay of Batavia, especially its southwestern corner (Onrust) are darker coloured than fishes from more northern islands, especially the Thousand Islands proper. Even at the reef of Edam this inclination for brighter coloration is recognizable already. This local difference in colour is distinct in *Premnas* and *Amphiprion polymnus* and *ephippium*.

There are three possibilities as to the value of such small colour differences. The first is that they represent mere colour changes, as, for instance, the colour assumed by flounders on a given background. The second is that they represent phaenotypical differences between different populations of a given species, as, for instance, the local varieties of molluscs in waters of different salinities. The third possibility is that these differences are genotypic.

The first possibility can probably be excluded. One could imagine that the silt quantity of the water worked as background and that near Onrust where the silt quantity can be so large, the fishes for that reason darken during periods of much silt and become lighter again when the water clears up. Such a colour change, however, should be visible to the eye. Moreover, damselfishes do not belong to those species, which exhibit rapid colour changes, such as play a role in *Epinephelus*, *Pseudoscarus*, *Pentapus*, *Scolopsis*, *Teuthis* and others (see the fine plates in TOWNSEND's paper!). For that reason I believe the first possibility can be dismissed of. — The second possibility is certainly much more probable. Local variations of a phaenotypical nature are wellknown in many animal groups. Nevertheless we can never be sure that local variations like the ones under discussion are not of genetic origin and for that reason the third possibility remains open. It would be interesting to show experimentally with what process we are dealing here; compare the studies and experiments on *Coregonus*, and especially those on *Zoarcas*, *Lebistes* and *Salmo* by SCHMIDT.

I first thought I had found in damselfishes, besides a local variation, a distinct geographical variation too. If we compare the measurements of damselfishes from the Philippines given by MONTALBAN with those of damselfishes from the Bay of Batavia, we find rather large and constant differences, MONTALBAN's animals being much smaller. Such a geographical variation in fishes is not impossible. It is true that generally spoken geographical variation occurs especially in land animals: mammals, birds, insects, reptiles; here the wellknown geographical races or subspecies occur which range over more or less extensive areas. But HEINCKE, HUBBS, PETROV, SCHMIDT and others have pointed out several cases of increase in size or in number of parts in colder waters and decrease in warmer waters (*Clupea*, *Sardinia*, *Leptocottus*, *Notimegonus*, *Alburnus*, *Gadus* and others). I therefore thought that all Philippine damselfishes would be smaller than those from Java and that we might be dealing with geographical differences here. To my surprise, however, I found that FOWLER and BEAN, measuring a smaller material, reach much higher maxima for the size of their damselfishes. I conclude from this that the small fishes of MONTALBAN represent at its most merely a local variety.



5. Colour change with age (I refer to fishes which have passed the first few weeks of their life) plays a part in *Amphiprion polymnus*, *A. ephippium* and possibly also in *A. akallopisus*. In *Amphiprion ephippium* the young get the first and an indication of the second white band of other damselfishes, which in *ephippium* from the Bay of Batavia both disappear again after some time. It is quite possible that the same is the case with *A. akallopisus*.
6. A review of the species of damselfishes in BLEEKER's List of the Pomacentrids from the East-Indian Archipelago probably looks as follows now:
- |  |   |
|--|---|
| <i>Premnas biaculeatus</i> (BLOCH) .....   | <i>Premnas biaculeatus</i> (BLOCH).               |
| <i>Amphiprion percula</i> (LACÉPÈDE) ..... | <i>Amphiprion percula</i> (LACÉPÈDE).             |
| <i>A. ephippium</i> (BLOCH) .....          | } <i>A. ephippium</i> (BLOCH). <sup>1)</sup>      |
| <i>macrostoma</i> (BLEEKER) .....          |   |
| <i>melanopus</i> (BLEEKER) .....           |   |
| <i>polylepis</i> (BLEEKER) .....           |   |
| <i>frenatus</i> BREVOORT .....             | } <i>A. polymnus</i> (LINNAEUS).                  |
| <i>A. polymnus</i> (LINNAEUS) .....        |   |
| <i>sebae</i> BLEEKER .....                 | } possibly<br><i>A. perideraion</i> BLEEKER only. |
| <i>A. akallopisus</i> BLEEKER .....        |   |
| <i>perideraion</i> BLEEKER .....           |   |
| <i>rosenbergii</i> BLEEKER .....           | } <i>A. bifasciatus</i> (BLOCH).                  |
| <i>A. bifasciatus</i> (BLOCH) .....        |   |
- If I am right in my assumptions there are in the Malay Archipelago 6 species of damselfishes only, 5 of which occur in the Bay of Batavia. *Amphiprion bifasciatus* was not yet found here.

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<sup>1)</sup> GÜNTHER (1875, p. 224) not only united *polylepis*, *melanopus*, *macrostoma* and *tricolor* (*frenatus*) with this species, but also what we now call *polymnus*. It is difficult to understand how he could come to such a conclusion, for both species have next to nothing in common. No one followed GÜNTHER in this.



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## FISH EGGS AND LARVAE FROM THE JAVA SEA <sup>1)</sup>

by

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### 16. *Amphiprion percula* C.V.

(With 6 figures).

In the foregoing papers of this series I have described pelagic eggs only. There are, however, several fishes in the Java Sea with demersal eggs and parental care or with eggs attached to sea-weeds or other objects. Thus the garfishes, half-beaks and flying fishes and also the numerous species of *Atherina* have eggs provided with filaments on the surface of the egg-membrane by which they are attached to floating or fixed objects. Other fishes — I mention e.g. *Sphyræna*, *Batrachus* and the Silurids — have such big eggs in the ripe ovary that one may conclude at once that the eggs are not pelagic. Also among the coral reef fishes there are probably many with nesting habits and parental care.

As an example of the latter I can give here a description of the eggs of *Amphiprion percula*. In the article preceeding the present one in this volume Dr. VERWEY has given his interesting observations on the symbiosis of these lovely Pomacentrids with big anemones of the genus *Stoichactis*. For the purpose of studying their life-history he kept a number of both in the tanks of the Onrust aquarium in which the fishes felt so at home that they bred regularly.

The eggs, each time numbering a few hundreds, were fastened to the wall of the tank next to the foot of the anemone. They have been discovered for the first time by Mr. STEINFURTH, the administrator of the quarantaine island Onrust, who has always taken a keen interest in the aquarium. Dr. VERWEY in his paper mentioned above has given a number of data regarding the periodicity of the spawning and the parental care so that I can confine myself to the description of the eggs themselves.

The eggs have an elongated shape and a length of about 2.2 mm. With one end they were attached by some glutinous substance to the perpendicular wall of the tank so that their position was horizontal.

<sup>1)</sup> cf. Treubia, Vol. II, p. 97, Vol. III, p. 38, Vol. V, p. 408, Vol. VI, p. 297, Vol. VIII, p. 199 and 389, Vol. IX, p. 338, Vol. XI, p. 275 and Vol. XII p. 37.



As mentioned by Dr. VERWEY spawning finds place during the night. If we examine an egg in the course of the first day (fig. 1) we see the germinal disc growing round the yolk. The egg does not fill up the whole egg-membrane but leaves a fairly considerable perivitelline space. The yolk has a yellowish tinge and contains one big and a number of smaller and of even very small oil-globules. These are all situated on the ventral side of the future embryo. In

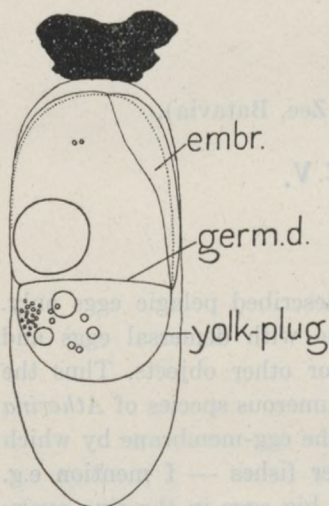


Fig. 1. Egg of the first day,  $\times 26$ . *embr.* rudiment of the embryo, *germ. d.* border of the germinal disc.

fig. 1 the yolk has been grown round by the germinal disc for about  $\frac{2}{3}$  and the first rudiment of the embryo has become distinct. We see from its situation that the animal pole of the egg is turned to the extremity of the egg membrane which is attached to the substratum.

In fig. 2, which has been drawn at 5.30 p. m. of the first day, the yolk blastopore has closed and the rudiment of the embryo now reaches from one pole of the egg to the other. The rudiment of the eye, of the ear vesicle and of some 9 myotomes have appeared. The head end is still turned to the side of the substratum.

In the course of the second day, however, we see the situation of the embryo within the egg membrane change, in such a way that at the end of this day the head is turned to the free extremity of the egg and the tail, now growing out, to the side of the substratum. This change is shown by figs. 3 and 4. The former of these has been drawn at 9.30 a.m. of the second day. The surface of the yolk is now dotted with black pigment cells of which a few are seen on the head of the embryo also. The smaller oil globules have disappeared. The number of myotomes has increased to 21-23 (incl. the caudal unsegmented part of the mesoderm bands). The head part of the embryo has left its terminal position, it has bent over the ventral surface of the egg and is moving along the latter to the position shown in fig. 4.

This figure has been drawn the next day 10 a.m. but we find the same situation at the end of the day before already. The head is turned now to the free extremity of the egg and the big oil globule lies close beneath it. The heart is beating and the blood may be seen flowing in the embryo and on the surface of the yolk, especially on the ventral side of the latter where the direction is from behind forward to the heart. The tail is growing out and may be moved to and fro.

Two days older is the egg shown in fig. 5. The eyes have become black which in pelagic eggs as a rule coincides with the complete absorption of the yolk. In our case, however, there is still a large amount of yolk present. The heart is beating at a rate of 150 per minute. Behind the ear vesicles the rudiment of the pectoral fins has appeared. Also the rudiment of the swimming bladder is visible.



The older the embryo the more it begins to move and to sprawl so that it becomes practically impossible to make drawings of the living egg with the drawing prism.

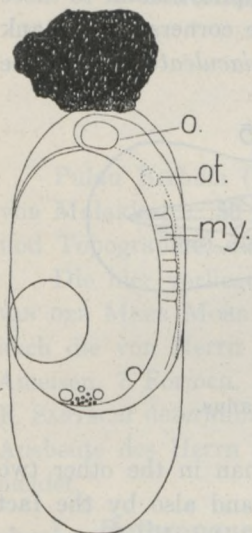


Fig. 2. Same egg at 5.30 p.m.,  $\times 26$ . *my* myotomes, *o* eye, *ot* otocyst.

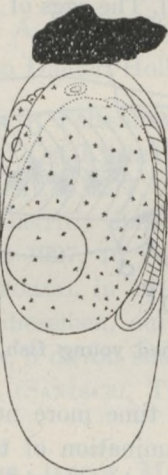


Fig. 3. Egg of the second day, 9.30 a.m.,  $\times 26$ .



Fig. 4. Egg of the third day, 10 a.m.,  $\times 26$ . *h* heart.

Hatching, as mentioned by Dr. VERWEY already, takes just a week, i.e. considerably longer than with pelagic eggs of which the smaller ones even take less than 24 hours to hatch. A newly hatched young is shown in fig. 6. It has a length of 4 mm. The yolk has not yet been resorbed and the oilglobule is still present. The first indication of the developing tail fin is visible. I counted 11 trunk myotomes and at least 15, but perhaps as many as 17, tail myotomes, excl. the terminal mesoderm knob. In the adult *Amphiprion percula* the number of vertebrae is 11 + 15 (incl. the urostyl). The situation of the anus, then, seems not to change anymore during development, the number of trunk vertebrae corresponding exactly to the number of trunk myotomes in the young.

Branching black pigment cells are present on the head, on the sides of the tail and above the swimming bladder. Besides these also round yellow pigment spots, not branching, are found here and there. To the naked eye the fishes make a grey impression. Only afterwards the orange colour and the white transverse bands appear, the latter, as mentioned by Dr. VERWEY,

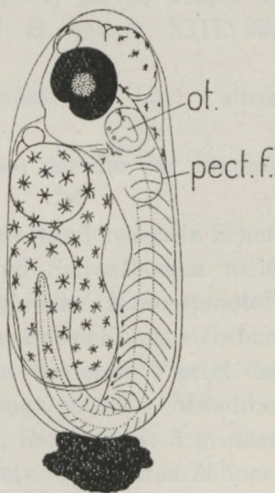


Fig. 5. Egg of the fifth day, 11 a.m.,  $\times 26$ . *ot.* otocyst, *pect. f.* pectoral fin.



from in front backwards, the anterior band appearing first and the posterior band last.

Besides *Amphiprion percula* also *A. ephippium* and *Premnas biaculeatus* have bred in the tanks. The eggs of the latter two appeared quite similar to those of *A. percula* but as they were attached in little accessible corners of the tank they have not been studied in detail. The eggs of *Premnas biaculeatus* seem to be

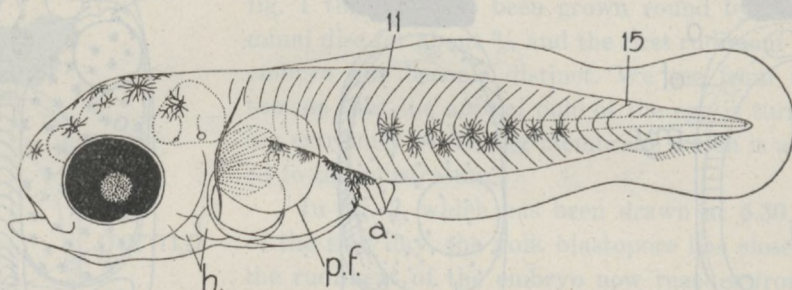


Fig. 6. Newly hatched young fish,  $\times 26$ . a, anus.

slightly smaller and at the same time more numerous than in the other two species. This is shown by an examination of the ovary and also by the fact that the newly hatched young have a length of 3.5 mm only (*Amphiprion percula* 4 mm). It is a curious fact that in *A. ephippium*, which has no transverse white bands in the adult state, yet such bands appear in the young, viz. the anterior one and an indication of the middle one. Afterwards they disappear again. For all this I refer to the paper of Dr. VERWEY.



## VERZEICHNIS DER BIS JETZT VON DER INSEL PULAU BERHALA BEKANNT GEWORDENEN AMEISEN.

Von

A. STÄRCKE

(den Dolder, Holland).

Pulau Berhala („île Varéla"), Felseninselchen mit Urwald in der Strasse von Malakka,  $\pm$  50 km von der Ost-Küste von Nord-Sumatra — s. die Karte und Topographie, diese Zeitschrift, p. 277.

Die hier vorliegende Liste betrifft die Ameisen-Ausbeute des Herrn J. C. VAN DER MEER MOHR im August 1927, 16 Formen. Zur Vervollständigung sind auch die von Herrn J. B. CORPORAAL in 1919 auf Pulu Berhala gesammelten Ameisen, 7 Formen, zum Teil dieselben, aufgenommen; letztere sind von Dr. F. SANTSCHI determiniert worden, 6 davon sind schon in der Liste der Sumatra-Ausbeute des Herrn CORPORAAL (SANTSCHI, Tijdschr. v. Ent. LXXI 1928) vermeldet.

1. **Bothroponera rufipes** JERDON, Madras Journ. Lit. Sc. v. 17. p. 119 (1851), (*Ponera*).

Fundort der Type: Malabar (JERDON).

Weiteres Vorkommen: Ganz Hindostan, Birma, Tenasserim, Ceylon, Borneo, Sumatra, Simaloor; ♀ Aug. 1927, J. C. VAN DER MEER MOHR no. 1. ♀ id. no. 2; ♀, larve, pupa, id. no. 7.

2. **Ectomomyrmex annamitus** ER. ANDRÉ (*Ponera*) Revue d'Ent. XI (1892). p. 48 (♀ ♀ ♂), v. **arcuata** FOREL, J. Bombay N. H. Soc. v. XIII, 322 (1900) (♀).

Fundort der Type der Art: Hué (Annam) nach ANDRÉ, der Var.: Calicut (ROTHNEY).

Weiteres Vorkommen: Birma, Annam (nach BINGHAM der die var. *arcuata* in Synonymie stellt).

♀. 4.8 mm. Kopf hinten konkav gestutzt; der stumpfe Rand zwischen Scheitel und Occipitalfläche deutlich, zwischen Scheitel und Seitenflächen nicht deutlich. Mesepisternum vom Sternum durch Naht geschieden. Meso-epinotal-Naht höchstens angedeutet, kaum und nur bei schiefer Beleuchtung sichtbar.

Kopf quadratisch; Augen klein, — 22 Fazetten, im vorderem Viertel des Kopfseitenrandes, von der Kieferwurzel nur um ihre Länge entfernt. Mandibel subtriangulär, mit Ecke zwischen inneren und Kaurand, letztere mit 5 groszen und 2 abwechselnd zwischen den proximalen 3 gestellten etwas kleineren Zähnen. Clypeusmitte leicht vorgebogen, ausserdem der starke Kiel in der Mitte in der Obenansicht wie ein dreieckiger Zahn prominent. Fühler plump, Scapus 0.82 mm; Funiculusglieder allmählich dicker, Glied 2-10 dicker als lang.

Kopf matt, gleichmässig, ziemlich grob punktiert-genetzt, Occiput glatt



und glänzend mit einzelnen feinen Pünktchen. Frontalfurche scharf aber untief, bis halbweg zum Occiput. Pro- und Mesothorax ebenso grob aber eine Spur oberflächiger punktiert, an den Seiten allmählich in Längsstreifung übergehend. Epinotum viel grober punktiert, dadurch schwarzer und weniger pubescent. Schon oben geht an den Seiten des E. die Punktierung in Punktstreifen und nach unten in scharfen Längsstreifen über.

Declive und Schuppe bogig quergestreift, genau wie FOREL v. *arcuata* beschreibt; nicht grob gerunzelt wie es bei ANDRÉ heisst. Gaster ziemlich dicht fein oberflächlich punktiert, kurz pubescent, schwach glänzend, auch das erste Segment. — (Bei der ♀, auf der die var. *arcuata* beschrieben ward, das erste Segment über drei Viertel dicht punktiert-genetzt, matt, wie Kopf und Thorax).

Pubescenz ziemlich dicht aber kurz, nirgends die Skulptur bedeckend, nur bei gewisser Beleuchtung sichtbar, blond. Schwarz mit rostroten Appendices und Gasterspitze. 2 ♀ aus gesiebten Aspleniumwurzeln, J. C. VAN DER MEER MOHR, Aug. 1927.

Der erste Fund dieser Art auf den Sunda-Inseln. Von den kleineren *Ectomomyrmex*-Arten käme nur noch *E. dahli* FOR. in Betracht. Der ist aber grösser (6.3 mm), hat Augen von  $\pm 50$  Fazetten; der Kopf ist etwas länger als breit, auf Stirn und Scheitel ordnen die Punkte sich zu Längsrünzeln; das erste und zweite Gastersegment dicht und fein längsgestreift.

### 3. *Euponera* (*Brachyponera*) *jerdoni* FOREL, J. Bombay N. H. Soc. v. XIII 324 u. 327 ♀ (*Ponera*).? var.

Fundort der Type: Poona (WROUGHTON).

Weiteres Vorkommen: Calcutta, Calicut, Barrackpore, Assam, Bengalen, West- und Süd-India.

Mit der Beschreibung in allen Hinsichten übereinstimmend, aber die Augen etwas grösser, 52-58 Fazetten („une quarantaine“ sec. FOREL); der Scapus überschreitet den Hinterhauptsrand mit seinem terminalen Diameter. Der Unterschied der Punktierung *luteipes* MAYR gegenüber ist auf dem Pronotum sehr auffallend, bei *luteipes* dort gedrängte grobe Punktierung, matt, die Zwischenräume so breit wie die Punkte, deren Centren 15-20  $\mu$  von einander entfernt sind, bei *jerdoni* (? var.) das Pronotum glatt, glänzend, mit mikroskopischen eingestochenen Pünktchen, 9-15  $\mu$  von einander entfernt.

	<i>luteipes</i> von Formosa (VIEHMEYER det.)	<i>jerdoni</i> von Pulau Berhala	<i>nigritella</i>
max. Breite Pronotum	575	538	620
Kopflänge ohne Kiefer	858	839	1013
Kopfbreite	766	730	885
Scapus ohne Gelenk	766	766	1040
Tibia post.	675	693	—
Augenlänge	155	155	173

In  $\mu \pm 4\frac{1}{2}$



Da FOREL besonders die Kleinheit des Auges der *jerdoni* hervorhebt, welche hier fehlt, und da die Patria der *jerdoni* ziemlich weit von der Strasse von Malakka entfernt ist, halte ich es für möglich dasz eine Var. vorliegt. Falls sie wirklich von *jerdoni* verschieden sein sollte, so möge sie v. **glabricollis** heissen.

Mehrere ♀, Urwald von Pulau Berhala, gesiebt; mit *Atopodon meermohri*, J. C. VAN DER MEER MOHR Aug. 1927, no. 9.

4. **Odontomachus haematoda** LINNÉ, Syst. nat. ed. 10, p. 382 (1758) ♀ (*Formica*).

Fundort der Type: Süd-Amerika (ROLANDER).

Weiteres Vorkommen: Tropicopolitisch.

♀♀. J. B. CORPORAAL, Nov. 1919; ♀ ♀. J. C. VAN DER MEER MOHR, Aug. 1927.

5. **Sima pilosa** F. SMITH, Cat. Hym. Br. Mus. v. 6, p. 160, (1858) ♀.

Fundort der Type: Borneo.

Weiteres Vorkommen: Sunda-Inseln, Singapore, Palawan (Phil.).

1 ♀, CORPORAAL, 2 Nov. 1919. SANTSCHI det.

(Dieser Fundort ist in der SANTSCHI-schen Arbeit über die Sumatra-Ausbeute CORPORAALS (Tijdschr. v. Ent., LXXI 119-140) übersehen worden).

6. **Crematogaster (Orthocrema) biroi** MAYR, Term. Füz. v. 20, p. 428 (1897) ♀. Var. **andelis** SANTSCHI, Tijdschr. v. Ent., LXXI, p. 129 (1928) ♀.

Type-Fundort; Pulau Berhala (CORPORAAL).

Weiteres Vorkommen der Var.: keine, der Art: Ceylon (Type, GREEN), Siam, Sumatra, Kanara, Dehra Dun (div. var.).

9 ♀ CORPORAAL, 2 Sept. 1919; viele ♀, 4 ♂, larvae, semipupa ♀, pupa ♀ und ♂, J. C. VAN DER MEER MOHR Aug. 1927.

♂ (noch nicht beschrieben). S. Pl. XVII, Fig. oben.

Von der Grösze der ♀ oder etwas kleiner, 1.7-1.8 mm. Gelblich weisz, Kopf licht braun, Gaster und Epinotum eine Spur bräunlich. Verhältnis der Teile aus der Figur ersichtlich. Glatt; abstehende Haare: (beide Seiten zusammen) 10 auf dem Scutum, davon 4 gröszere, 6 kleinere, 6 auf dem Scutellum, davon 2 auf der Scheibe. MAYR'sche Furchen angedeutet, Hinterteil des Scutums und Scutellum zwischen den etwas höheren Seitenteilen eingesenkt. Petiolus und Postpetiolus fast gleich breit, der freiliegende Teil des Postpetiolus 2 × breiter als lang, queroval, nicht gefurcht; der Petiolus eine Spur schmärer, fliessend gestielt (s. Fig.) Hinterschienen an der Streckseite mit 3-4 40<sup>0</sup> abstehenden Haaren. Zweites Fühlerglied stark aufgetrieben. Fühlerglieder (11) mit einer fast wagerecht abstehenden Behaarung, die kürzer (1/2-) als die Dicke des Gliedes ist, nach dem Ende zu schiefer. Auge konvex, so lang als die Hälfte der Kopfseite von Mandibelecke bis Hinterhauptsrand, von der Vorderecke 1/4 seiner Länge entfernt. Augenlänge 182 µ, Breite 136 µ; vom Auge bis zur nächsten Ozelle 114 µ. Kopf zwischen den Augen 290 µ. Ozellen grosz, oval, im stumpfen



Dreieck. Länge der lateralen Ozele 62  $\mu$ . Clypeus breit trapezförmig vorspringend, mit geradem Vorderrande. Stipes kurz, breit, stumpf abgerundet, abgestutzt, auch in Milchsäure nicht vortretend.

Der Unterschied gegenüber *fritzi* EM. ist in der Antenne deutlich: *fritzi* 10-gliedrig, *biroi* 11-gliedrig, das Endglied ist bei *fritzi* viel dünner, bei *biroi* fehlt die Auftreibung des 6en Gliedes, das 2e Glied ist dagegen noch stärker aufgetrieben, der ganze Fühler dicker, aber normaler von Gliederung. Das Scutum hat bei *fritzi* ♂ 5 tiefe Längslinien, von denen die mittlere die tiefste ist, zusammen münden sie hinten in einer tiefen, breiten Grube, die nach hinten von den stumpfen dicken Längsleisten dreieckig abgeschlossen wird. ♀ semipupa 4 mm.

7. **Crematogaster (Orthocrema) millardi** FOREL, Rev. Suisse zool. v. 10 p. 205 (1902) ♀.

Fundort der Type: Moulmain (Birma, HODGSON).

Weiteres Vorkommen: Singapore.

Mehrere ♀, larva, pupae, Aug. 1927, J. C. VAN DER MEER MOHR. 1.7-1.9 mm. (1.9-2 mm teste FOREL). Mittelfurche des Postpetiolus ziemlich kräftig.

Bei den kleineren Stücken erreicht der Scapus nicht vollkommen den Hinterhauptsrand.

8. **Crematogaster (Orthocrema) treubi** EMERY, Ann. Soc. ent. Belg. 1896 p. 246. ♀.

Type-Fundort: Buitenzorg.

Weiteres Vorkommen: Java, Celebes, Kuala Lumpur (Malakka), Sumatra.

Viele ♀. Aug. 1927, J. C. VAN DER MEER MOHR.

Etwas grösser als die Type (2½ bis 3 mm gegen 2¼ bis 2½) aber nicht dunkel wie die ssp. *vastatrix* FOREL. Die abstehenden Haare an Tibien und Scapus nicht auffallend kurz und stehen fast senkrecht ab („schief“ bei der Type). Diese Unterschiede scheinen zu gering um eine Varietät darauf zu basieren.

9. **Monomorium floricola** JERDON, Madras Journ. Lit. Sc., v. 17 p. 107 (1851) (Atta).

Fundort der Type: Tellicherry (Süd-India), (JERDON).

Weiteres Vorkommen: tropicopolitisch.

♂ CORPORAAL, 2 Nov. 1919.

10. **Dolichoderus (Hypoclinea) bituberculatus** MAYR, Verh. zool.-bot. Ges. Wien, v.12, p. 705 (1862) ♀.

Fundort der Type: Luzon (Philippinen).

Weiteres Vorkommen: West-India, Sikkim, Indo-China, Sunda-Inseln bis Neu-Guinea.

Mehrere ♀ larva, pupa, Aug. 1927, J. C. VAN DER MEER MOHR.

?10a. *Dolichoderus (Hypoclinea) bituberculatus* MAYR var. *bornensis* FOREL. Mehrere ♀, CORPORAAL. Nach SANTSCHI. Ich zeichne bei diesem Namen



an dasz eine var. *bornensis* FOREL nur von *D. taprobanae* SM. beschrieben ist. Auf eine diesbezügliche Frage antwortete mir Dr. SANTSCHI dasz die *Dolichoderus*-Arten der *bituberculatus*-Gruppe eine Revision bedürfen. Die von CORPORAAL früher auf P. Berhala gesammelten *bituberculatus*-Arbeiterinnen sind von jenen der Ausbeute-VAN DER MEER MOHR nicht verschieden. Die Farbe ist nicht sehr dunkel und die Pubescenz auf dem Kopfe nicht dicht, aber solche Stücke kommen auch in den typischen javanischen Kolonien der Art vor. Die var. *borneonensis* ROG. 1863 scheint mir sehr fraglich von der Type verschieden.

### 11. *Technomyrmex* sp.

1 ♀, ohne Kopf. Aus gesiebten Asplenium-wurzeln, Aug. 1927, J. C. VAN DER MEER MOHR.

Schlank, Körperform etwa wie bei *Iridomyrmex watsoni*, auch die Form des Epinotums wie bei dieser; Declive, Schuppe und Gaster aber durchaus *Technomyrmex*-artig. Gelblich graubraun, Gaster und Oberplatte des Petiolus etwas dunkler. Opak, dicht punktiert-genetzt; bei 25 × keine Pubescenz sichtbar. Gaster glänzend, dicht mikroskopisch punktiert; bei 25 × eine sehr feine und dichte Pubescenz sichtbar. Abstehende Behaarung spärlich am Gaster, keine an Thorax und Beinen. Auf dem Pronotum werden bei 25 × einige sehr feinen und kurzen aufrechtstehenden Härchen sichtbar, von den Dimensionen der Pubescenz. Länge des Fragmentes 2.1 mm. Schlanker und weniger pubescent als *T. textor* FOR., deren Farbe und Grösze es ungefähr hat.

### 12. *Atopodon meermohri* nov. sp. (Pl. XVIII, Fig. oben).

♀. Nahe *inezae* FOREL 1913; hat aber 4 fast gleich grosse vordere Mandibelzähne; der Thorax ist zwischen Meso- und Epinotum tüchtig eingeschnitten; der Scapus erreicht fast den Hinterhauptsrand. Funiculus-Glieder 2-8 kürzer als breit bis höchstens so lang als breit, die mittleren fast 2 × dicker als lang; Endglied etwas schmaler als das vorige, konisch. Ziemlich glänzend; obwohl eine nicht sehr dichte, äusserst feine Pubescenz vorhanden, überdeckt diese nur auf den Antennen und Beinen den Glanz der Chitinhaut, und ist nur bei schiefer Beleuchtung als leichter Flaum sichtbar. Abstehende Behaarung auf Kopf und Thorax spärlich, auf dem Gaster reichlicher. S. Pl. XVIII, Fig. oben, 1.9-2 mm. Farbe von *Lasius flavus*.

Das Auge auf der Foto unsichtbar, steht auf der Vorderseite, auf der Grenze des vorderen Drittels (*inezae*  $\frac{1}{4}$ ) und besteht aus einer Fazette.

Mehrere ♀♀ aus Waldboden 60-70 M über dem Meer gesiebt. Aug. 1927, J. C. VAN DER MEER MOHR. Type m.c.

Die Art kann von den nahestehenden wie folgt unterschieden werden:

1. Vier distale Zähne auf einer Linie mit dem breiten abgestutzten proximalen Zahn ... 2.

Der breite Zahn von den anderen entfernt am Kieferinnenrand, abgestutzt  
*butteli* FOR.







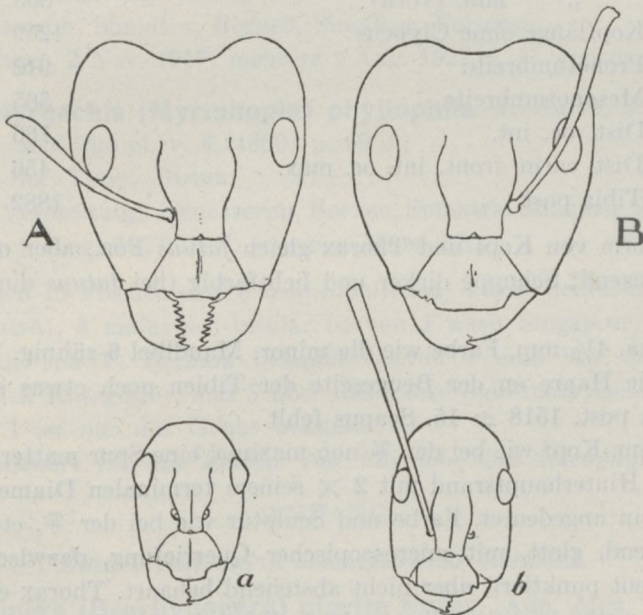
Grübchen angedeutet ist. Der Scapus reicht genau bis zur Hinterhauptsecke, gerade zurückgelegt seinen terminalen Diameter weiter als der Occipitalrand, Scapus cylindrisch, abstehend behaart, Funiculusglieder 2-9 doppelt so lang als breit, rotgelb, dicht pubescent, nicht abstehend behaart. Max.-taster weisslich, kurz; letztes Glied so lang wie vorletztes, etwas kürzer als das zweitletzte. Thoraxprofil im Viertelkreis etwas elliptisch wie bei *fatuus* FOR., kürzer als *irritans* FOR.; Schuppe hinten fast gerade, eine Spur konvex, vorn konvex, unten dicker als bei *pallidus* MAYR, regelmässig spitz abgerundet, schmal. Gaster etwas schmaler als der Kopf.

Ziemlich glänzend, bei  $25 \times$  fein genetzt; die Querriefen etwas höher, zerstreut punktiert, an den Wangen und Schläfen etwas dichter  $\pm 30$  per Wange.

Thorax ebenso glänzend, bei  $25 \times$  genetzt; Gaster glänzend, bei  $25 \times$  spurweise genetzt hie und da mit mikroskopischer Querriefung.

Bei  $25 \times$  keine Pubescenz sichtbar. Abstehende Behaarung mässig, rötlich, so lang als der Hals hoch; am ganzen Thorax im Profil  $\pm 25$  Haare, an der Schuppe 8, auf dem Gaster in derselben Dichte wie am Thorax, an den Segmenträndern und sehr zerstreut auf der Scheibe. Am Kopfe einige zerstreuten Haare, meist kürzer als am Thorax, auf der Wange 5-8 kurze Härchen (kürzer als der Scapus dick). Unterseite des Kopfes ziemlich kurz zerstreut abstehend behaart.

Beine kurz, schienen kompress, jederseits ziemlich reichlich  $40^\circ$  abstehend behaart; an der Beugeseite dazwischen einzelne stärkeren Dörnchen, deren Unterscheidung von den Haaren nur mikroskopisch gelingt.



Textfig. 1. — A.a.: ♂ ♀ *Camponotus* von P. Berhala.

B.b.: ♂ ♀ *C. irritans* FOR. von Java (Semarang).



In  $\mu \pm 15$ .

	no. 1	no. 2
Kopfbreite max.	2277	2095
„ min.	1397	1214
Dist. int. oc.	1457	1397
Dist. car. front. int. oc.	607	668
Tibia post.	2247	2247

♀ minor.  $6\frac{1}{2}$  mm. Gestreckter, und etwas lichter gefärbt; der Mittellücken oben fast gerade, ebenso wie der basale Teil des Epinotums, der doppelt so lang ist als die Declive in welcher er ohne Grenze mit Bogen übergeht. Kopfseiten gerade, nach vorn eine Spur konvergierend, hinter den Augen abgerundet konvergent, Type  $\beta$  von EMERY; Occipalrand  $\frac{1}{3}$  der Kopfbreite, gerade. Mittellobus des Clypeus breit, kurz, der Rand schwach gebogen, die Ecken schief abgerundet. Carina des Clypeus scharf, ganz vorn und hinten verwischt. Kopf ohne Clypeus  $\pm$  so lang wie breit; Kopf ohne Kiefer No. 1:  $1.62 \times 1.20$  mm, No. 2:  $1.50 \times 1.14$  mm. Keine Stirnfurche; der Scapus überragt den Hinterhauptsrand mit fast der Hälfte seiner Länge. Mandibel 6-7-zählig. Schuppe relativ niedriger, nicht kürzer. Sculptur und Behaarung wie der ♀. Gelblich rostfarben, Kopf und Gaster stark angeräuchert, letzteres hinten schwärzlich; Rücken leicht angeräuchert.

In  $\mu \pm 15$ .

Kopfbreite max. (mit Augen)	1168
„ min. (vorn)	803
Kopflänge ohne Clypeus	1259
Pronotumbreite	912
Mesonotumbreite	565
Dist. oc. int.	766
Dist. carin. front. int. oc. max.	456
Tibia post.	1882

In der Form von Kopf und Thorax gleich *fatuus* For., aber nicht so ganz glatt und glänzend; Schuppe dicker und lichtfarbig (bei *fatuus* dunkler als der Thorax).

♀ minima.  $4\frac{1}{2}$  mm. Farbe wie die minor. Mandibel 6-zählig. Ubrigens wie die minor. Die Haare an der Beugeseite der Tibien noch etwas schiefer, fast liegend. Tibia post.  $1518 \pm 15$ . Scapus fehlt.

♀.  $13\frac{1}{2}$  mm. Kopf wie bei der ♀ non maxima, eine Spur matter. Der Scapus überragt den Hinterhauptsrand mit  $2 \times$  seinem terminalen Diameter. Frontalfurche haarfein angedeutet. Farbe und Sculptur wie bei der ♀, etwas dunkler, mäsrig glänzend, glatt, mit microscopischer Querriefung, dazwischen genetzt. Wangen zerstreut punktiert, aber nicht absteht behaart. Thorax etwas stärker angeräuchert, rotbraun; Scutellum schwärzlich wie das Gaster, im deutlichen Kontraste zu Scutum und Epinotum, Schuppe viel kürzer (dünner), breiter, hoch wie  $\frac{2}{3}$  des Epinotums, oben breit ausgerandet; Vorder- und Hinterseite bis zu



halberhöhe parallel, dann im Profil vorne schief zugespitzt. Vorderflügel  $10\frac{1}{2}$  mm, vorn proximal sehr schwach gelblich. Tibia post.  $2490\ \mu$ ,  $\pm 15$ .

Mehrere ♀, ♀ minor, ♀ minima, ♀, die meisten zerstückelt, wie so oft bei *Camponotus*. Aug. 1927, J. C. VAN DER MEER MOHR no. 3 u. 4.

16. **Camponotus (Myrmamblys) reticulatus** ROG., **bedoti** EMERY, Rev. Suisse zool. v. 1. (1893), p. 196, pl. 8, fig. 2. (sp.).

Fundort der Type: Batjan.

Weiteres Vorkommen: N.-Guinea, Ternate, Sula, Morty, Sarawak, Medan, Indrapoera, Tandjong Priok, Krakatau.

1 ♂ CORPORAAL, 2 Nov. 1919.

17. **Camponotus (Colobopsis) vitreus** F. SMITH var. **oebalis** FOREL, Notes Leyden Mus. v. 33 (1911) p. 208. ♀.

Fundort der Type: Semarang 1000 M. (Java, JACOBSON).

Weiteres Vorkommen: Unbekannt.

Viele ♀ Aug. 1927, J. C. VAN DER MEER MOHR.

Diese Form — m. E. eine Spezies — die oberflächlich in Habitus an *Lasius fuliginosus* erinnert, wird hier abgebildet (S. Pl. XVII Fig. unten).

18. **Polyrhachis (Myrma) mayri** ROGER, Verz. Formic. Gatt. u. Arten (1863) p. 7. MAYR, Verh. zool.-bot. Ges. Wien v. 12 (1862) p. 685 („*Aelucens* LATR.“).

Fundort der Type: Java (KIRSCH).

Weitere Verbreitung: Bengalen, Sikkim, Kanara, Travancore, Ceylon, Birma, Tenasserim, Sumatra, Borneo, Simaloer, Formosa.

♀ CORPORAAL, 2 Nov. 1917; mehrere ♀ Aug. 1927, J. C. van der MEER MOHR.

19. **Polyrhachis (Myrmhopla) phyllophila** F. SMITH, J. Proc. Linn. Soc. London, zool. Suppl. v. 4 (1860) p. 69 ♀.

Fundort der Type: Birma.

Weitere Verbreitung: Tenasserim, Borneo, Sumatra, Simaloer, Java, Celebes.

Einzelne ♀ Aug. 1927, J. C. VAN DER MEER MOHR.

Von diesen 18 Formen sind 3 tropicopolitisch, 4 kontinental-indisch (davon 1 auch Sumatra), 3 malayisch-insulär (davon 1 auch Singapore, 1 auch Malakka), 2 nur von P. Berhala bekannt (davon 1 eine Var. einer Art der nächstfolgenden Kategorie), und 5 über das ganze indo-malayische Gebiet verbreitet. Von 1 ist nur das Genus bekannt.

Bemerkenswert ist das Fehlen von *Pheidole* und *Oecophylla*.

## ANHANG.

### ZWEI INTERESSANTE SUMATRANISCHE AMEISEN.

I. **Euponera (Brachyponera) nigrita** EMERY, Ann. Mus. civ. Gen. v. 34 (1894) p. 459.

Subsp. **nigritella** nov.



Schlank, wie *nigrita*, aber kleiner, 4.3 mm (*nigrita* 5.5-6). Kopf ohne Kiefer um  $\frac{1}{7}$  länger als breit. Entfernung des Auges von der Kieferwurzel  $\frac{6}{7}$  der Augenlänge. Schulterecken deutlich angedeutet, aber abgerundet; Mesonotum bombierend, Thorax zwischen den Teilen wenig eingeschnürt.

Länge des Epinotums 0.77 mm, der Schuppe (ohne Stielchen) 0.31 mm. Knoten viel breiter als bei *luteipes*, an *sennaarensis* erinnernd, aber weniger vorüberbeugend, von oben gesehen trapezoid mit abgerundeten Ecken, Seiten leicht konkav, vorn in der Mitte vorspringend, hinten gerade und sehr wenig davor und oben am breitesten, 0.47 mm, vorne unten am schmalsten, 0.24 mm; im Profil trapezoid, hoch wie das Epinotum, Vor- und Hinterprofil gerade in der Mitte, an die Seiten beugt sich die Hinterfläche auf  $\frac{3}{4}$  der Höhe leicht konvex und nach vorn geneigt,  $\frac{1}{2}$  so lang als die Schuppe unten, dreimal breiter als lang, hinten gerade, aber ohne Grenze, vorn oval begrenzt. Basalteil des Epinotums mit lineärem stumpfem Grate, jederseits sehr steil abfallend; abschüssiger Teil wie ein gothisches Fenster zum Grat emporsteigend, im Profil erst steil gerade, in  $\frac{2}{3}$  der Höhe bogenförmig, in dem geneigten etwas gebogenen erweiterten Hinterteile des Grates übergehend, nur dieser Teil konkav, die ganze Declive glatt, sehr glänzend. Basalteil eine Spur länger als Declive; Seitenränder des letzteren scharf. Kopf unmittelbar hinter den Augen am breitesten; Seiten abgerundet, Hinterseite deutlich ausgerandet. Fühler schlank; Scapus überragt den Hinterhauptsrand mit  $\frac{1}{4}$  seiner Länge (mehr als  $3 \times$  seinem terminalen Diameter); alle Funiculusglieder länger als breit, die ersten  $1\frac{1}{2} \times$  so lang als breit, allmählich dicker, das 10e fast so breit als lang. Clypeus vorne über circa  $\frac{1}{3}$  seiner Breite (schmäler als *luteipes*) schwach aber deutlich ausgerandet, in der Mitte eine tiefe breite Längsgrube zwischen stumpfen Leisten, Frontalgrube bis  $\frac{2}{5}$  der Kopflänge eben angedeutet.

Durch eine feine lichte Pubescenz überhaucht, Kopf, Fühler und Beine dadurch matt, Scheitel und Occiput schwach glänzend. Scrobus dicht liegend gelblich behaart. Kopf fein und dicht punktiert etwa eine Spur grober als *Ponera punctatissima*. Gaster vom zweiten Segment an ebenfalls schwach glänzend, pubescent überhaucht.

Erstes Segment, Schuppe und Thorax viel weniger überhaucht, ziemlich stark glänzend, am stärksten auf dem Mesonotum. Pronotum dicht und grober als der Kopf punktiert; nur wenig oberflächlicher als *luteipes*; der übrige Körper sehr fein punktiert. Abstehende Behaarung fast fehlend, nur auf den Segmenträndern des Gaster, auf der Schuppe und am Clypeusrande vereinzelt.

Schwarzbraun, Appendices und Segmentränder des Gaster, sowie die letzten Segmente selbst lichter. Fühlerschaft und proximale Hälfte des Funiculus dunkel, distale Hälfte allmählich lichter bis braungelb.

Bei der ebenfalls kleineren subsp. *chinensis* EM. 1894, p. 460 nehmen nach der Beschreibung die Fühlungsverhältnisse eine Mittelstellung zwischen *nigrita* und *luteipes* ein; die hier beschriebenen Stücke stimmen darin mit *nigrita* überein. Ausserdem ist es nicht wahrscheinlich dass die chinesische Rasse einer birmanischen Art mit der sumatranischen Form identisch sein sollte.



Mehrere ♀. Fort de Kock (Sumatra) Oct. 1913. E. JACOBSON. Museum Leiden No. 1245, gezettelt: *Ponera luteipes* MAYR, CRAWLEY det.

II. **Dolichoderus (Hypoclinea) indrapurensis** FOREL, Zool. Jahrb. Suppl. XV, Bd. 1 (1912) p. 61.

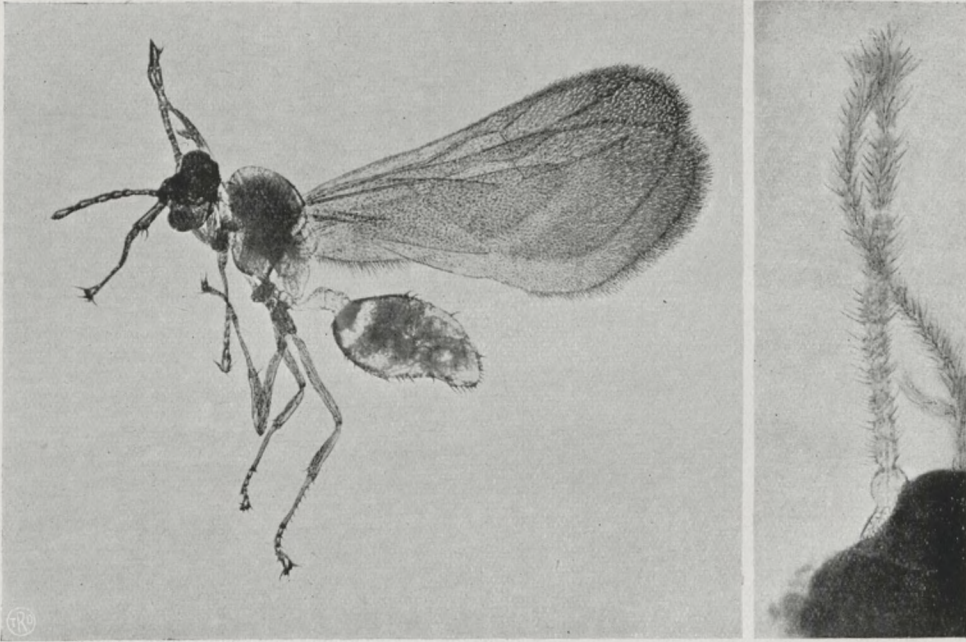
Typen-Fundort: Indrapura (TRITSCHLER).

Weitere Verbreitung: Soengi Bambau (Tiefeland, v. BUTTEL-REEPEN) 1 ♀ zwischen Serdang und dem Toba See, Dr. B. HAGEN. (S. Pl. XIX).









Oben: — *Crematogaster biroï* var. *andelis* SANTSCHI ♂.  
 × 22. — Fühler × 90.6.

BERLESE-Praeparat nach DOCTERS VAN LEEUWEN.

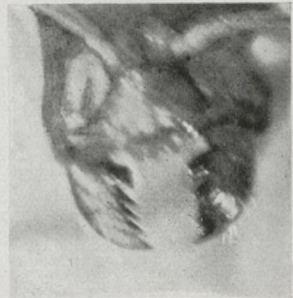
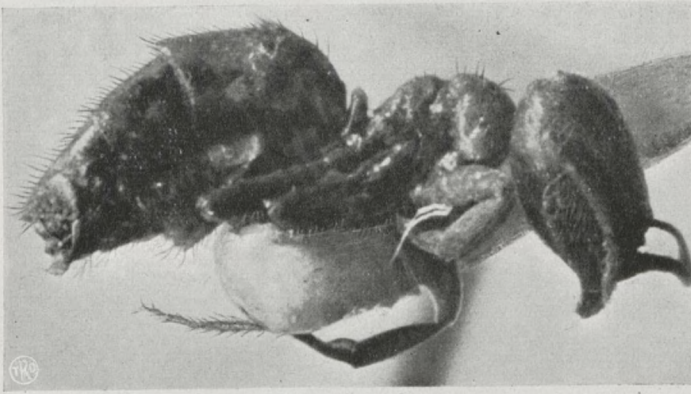
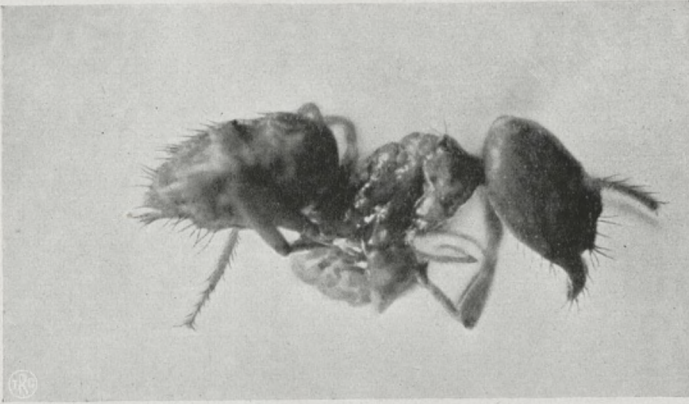
Die Streifung an den Gliedmassen ist keine Behaarung sondern die quergestreifte Muskulatur. Im Petiolus sind das Ganglion, der Oesophagus und die medialen und lateralen Muskeln sichtbar, im Thorax die Flügelmuskeln.

Unten: — *Camponotus vitreus* Sm. var. *oebalis* FOR. × 20.  
 Man sieht die beiden Spitzen der Schuppe.









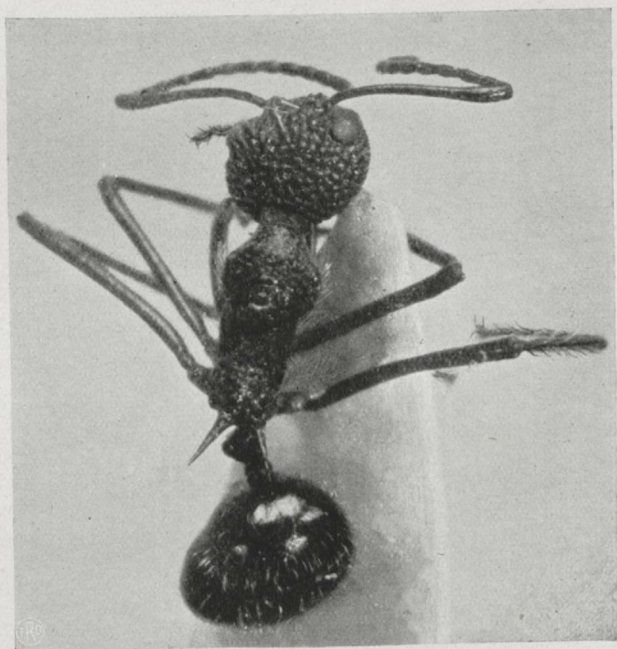
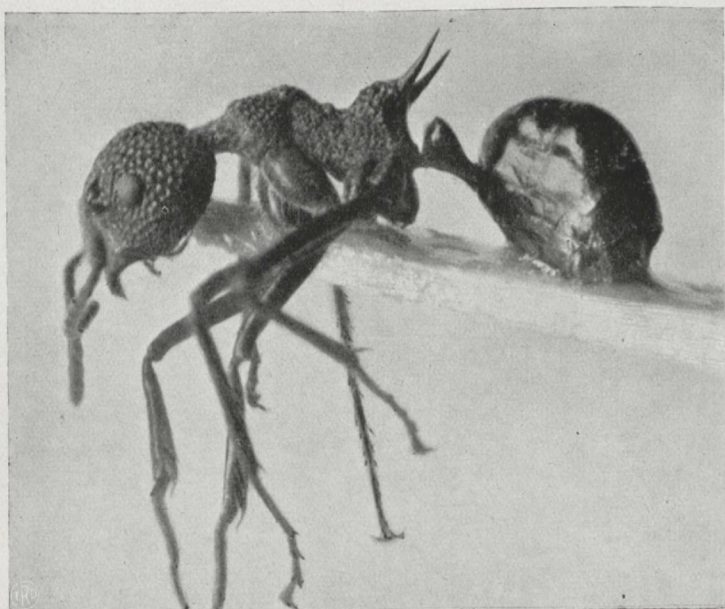
Oben: — *Atopodon meermohri* nov. spec. ♀, Type. P. Berhala.

Unten: — *A. amblyops* For., Lectoholotype, Simaloer.  
Seitenansicht  $\times 32$ ; Kopf  $\times 35$









*Dolichoderus indrapurensis* FOR. ♀.  
Serdang-Tobasee.  $\times 13.3$ .







# BESTIMMUNGSSCHLÜSSEL DER GATTUNG LYROPAEUS C. O. WAT.

Von

R. KLEINE,  
(Stettin).

WATERHOUSE hat die Gattung 1878 in den Trans. Ent. Soc. aufgestellt und den *Lycus fallax* WALKER als Typus bestimmt. Die Gattung ist eine der wenigen in den Lycidae, die so scharf umschrieben ist, dass über die Abgrenzung keine Zweifel bestehen. Die Arten sind im Habitus äusserst einheitlich, sodass bei ihrer Unterscheidung sehr erheblich auf die Ausfärbung zurückgegriffen werden muss. Das ist bei *Lyropaeus* aber auch ganz unbedenklich, da gerade in der Farbenverteilung eine grosse Konstanz besteht und die Trennung der Arten leicht und sicher durchzuführen ist. Der nachstehende Schlüssel soll eine Zusammenfassung und Uebersicht der bekannten Arten geben und zugleich das, was mir als wichtig darüber zu sagen erscheint.

## BESTIMMUNGSSCHLÜSSEL.

1. Prothorax rot, orange oder gelb . . . . . 2  
Prothorax schwarz oder mehr oder weniger braun . . . . . 10  
Prothorax bunt . . . . . 17
2. Elytren einfarbig rot, orange oder gelb . . . . . 3  
Elytren bunt . . . . . 7
3. Fühler ganz dunkel gefärbt, keine Glieder sind hellfarbig . . . . . 4  
Fühler von anderer Färbung . . . . . 5
4. Schildchen, Prothorax und Elytren orange gelb . . . . . *philippinensis* KLN.  
Schildchen schwärzlich oder doch wenigstens dunkel . . . . . *coccineicollis* PIC.
5. Fühler einfarbig orange gelb . . . . . *grandissimus* KLN.  
Fühler bunt . . . . . 6
6. Schwarz, 8.-11. Fühlerglied dunkel, Stirn mit langer Mittelfurche . . . . .  
*aurantiacus* BOURG.  
Dunkelbraun, 10.-11. Fühlerglied dunkel, Stirn ungefurcht . . . . . *granulosus* KLN.
7. Alle Fühlerglieder schwarz oder schwarzbraun . . . . . 8  
Von anderer Farbe . . . . . 9
8. Schildchen orange, Elytren nur in den hinteren  $\frac{2}{3}$  und nur an der  
Sutura schwarzbraun . . . . . *philippinensis* KLN.  
Schildchen schwarz, Elytren in der hinteren Hälfte mit einer breiten,  
zackigen schwarzen Binde . . . . . *fallax* F. WALK.



9. Die 4 oder 5 Spitzenglieder der Fühler sind braunschwarz, Elytren hinter der Mitte mit einer mehr oder weniger deutlichen kreisförmigen Verdunkelung . . . . . *biguttatus* GORH.  
Fühler ganz rotgelb, Elytren dunkel mit hellem Humerus . *contrarius* KLN.
10. Elytren einfarbig rot, orange oder gelb . . . . . 11  
Elytren von anderer Farbe . . . . . 13
11. Trochanteren und Basis der Schenkel rötlich . . . . . *dohertyi* PIC.  
Beine einfarbig dunkel . . . . . 12
12. Elytren hinter der Mitte stark erweitert, 3. Rippe ganz obsolet und durch dichte Behaarung verdeckt . . . . . *densepilosus* KLN.  
Elytren parallel, Rippen normal . . . . . *gorhami* PIC.
13. Elytren einfarbig schwarz . . . . . *optabilis* KLN.  
Elytren bunt . . . . . 14
14. Die helle Partie auf den Elytren findet sich nur schmal am Humerus  
*humeralis* n.sp.  
Die helle Partie nimmt wenigstens das vordere  $\frac{1}{3}$  ein . . . . . 15
15. Die dunklen Farbenpartien liegen dem Hinterrand oder den Seitenrändern in der hinteren Hälfte an . . . . . *laticollis* PIC.  
Die Farbenpartien sind quer geteilt . . . . . 16
16. Die Elytren sind nach hinten erweitert, die helle Farbe ist gelborange  
*ritsemae* GORH.  
Elytren parallel, die helle Partie ist rotorange . . . . . *longipennis* PIC.

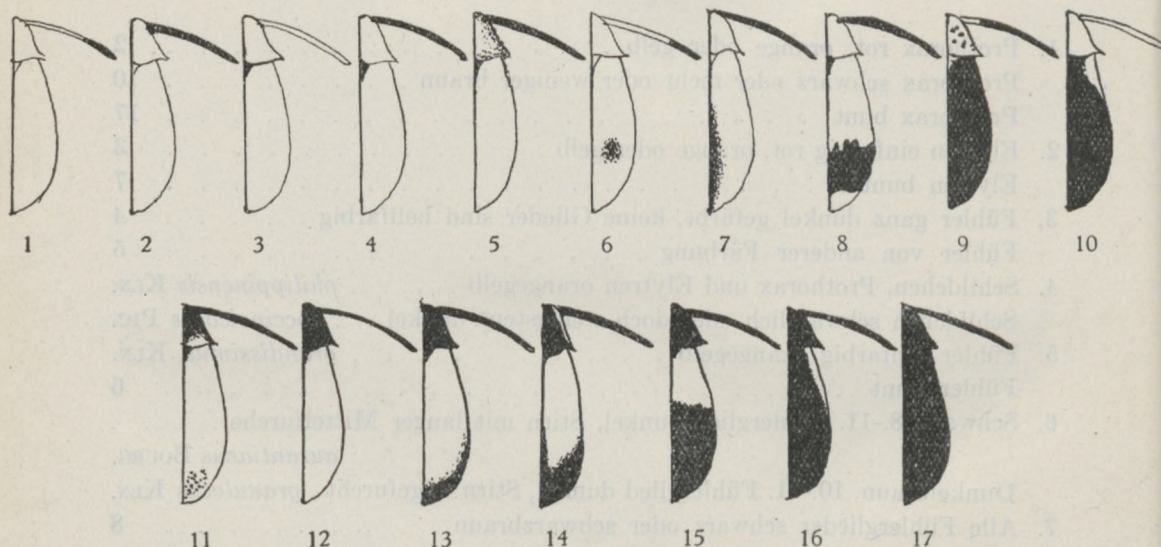


Fig. 1. — *Lyropaeus*, Färbungstypen.

Nr. 1 *L. aurantiacus, granulosus*; 2 *philippinensis*; 3 *grandissimus*; 4 *coccineicollis*; 5 *waterhousei*; 6 *biguttatus*; 7 *philippinensis*; 8 *fallax*; 9 *cinnamomi*; 10 *contrarius*; 11 *binotatus*; 12 *dohertyi*, *densepilosus*, *gorhami*; 13 *laticollis*; 14 *bicolor*; 15 *ritsemae*, *longipennis*; 16 *humeralis*; 17 *optabilis*.



17. Prothorax vorherrschend dunkel gefärbt, nur die Ränder sind mehr oder weniger hellfarbig . . . . . 18  
 Prothorax hellfarbig mit dunklen Zeichnungen . . . . . 19
18. Prothorax an den Seitenrändern rot, Elytren im Apicalteil schwarz . . .  
*bicolor* PIC.  
 Prothorax am Hinterrand rot, Elytren im Apicalteil nur unscharf, schwach angedunkelt . . . . . *binotatus* PIC.
19. Elytren rauchbraun, Schildchen, Prothorax und die ersten Fühlerglieder rot, Prothorax dunkel gefleckt . . . . . *cinnamomi* KLN.  
 Elytren rot orange, Schildchen braunschwarz, Fühler desgleichen, Prothorax rot orange, nach den Rändern zu dunkel gefärbt. . *waterhousei* GORH.

## BEMERKUNGEN ZU DEN EINZELNEN ARTEN.

*philippinensis* KLN. Philipp. Journ. Sc. XXXI, (1) 1926, p. 78.

Kleinere Art, 5.5-6.5 mm lang. Die einzige Art, die von den Philippinen bekannt geworden ist. Fundorte: Mindanao, Provinz Surigao, Surigao; Provinz Lanao, Iligan. *Philippinensis* ist zu den variablen Arten zu zählen, ich habe daher auch 2 Verteilungsbilder wiedergegeben. Der Prothorax kann am Vorderrand verdunkelt sein, die graubraune Farbe kann sich über das Schildchen bis auf die Elytrenbasis erstrecken, selbst die Elytren können mehr oder weniger schwarz werden. Die grosse Variation mahnt bei Festlegung der Art zur grössten Vorsicht. Die Färbungsdifferenzen sind alle an männlichen Tieren festgestellt, deren Artzugehörigkeit durch Penisautopsie gesichert ist.

*coccineicollis* PIC. Mél. 7. 1913, p. 6.

Grössere Art, 14 mm lang. Indien: Chamlaganor. Der Autor vergleicht die Art mit *waterhousei* GORH. Der Prothorax ist aber einfarbig und nicht gefurcht, die Elytren haben nur 3 Rippen. Ich habe die Art selbst nicht gesehen. Die Diagnose PIC's ist aber sehr ausführlich.

*grandissimus* KLN. Ind. For. Rec. part VI, XIII, 1929, p. 257.

Sehr grosse Art, 21 mm lang. Indien: Chamenkaia Hill. Die Riesenart ist mit keiner anderen zu verwechseln. Sie ist durch die Ausfärbung, namentlich durch die gänzlich orangefarbenen Beine, bei sonst dunkler Körperfärbung gekennzeichnet.

*aurantiacus* BOURG. A.S.E. Fr. LXXVII, 1908, p. 503.

Mittelgrosse Art, 12 mm lang. Indien, Travancore. Ich fand einen *Lyropaeus* aus Cochinchina (Berliner Museum), der nach der Beschreibung zu dieser Art gehören könnte. BOURGOIS vergleicht seine Art mit *fallax* WALK., die auch sicher die nächststehende Art ist. Die Unterscheidung ist sehr leicht, die breite schwarze Binde, die für *fallax* so charakteristisch ist, fehlt vollständig.

*granulosus* KLN. Stett. Ent. Zeit. LXXXI, 1930, p. 102.

Kleinere Art, 8 mm lang. Süd-Indien: Kanara.



*fallax* F. WALK. Ann. Mag. Nat. Hist. 1858, II, p. 281.

Mittelgrosse Art, 10 mm lang. *Fallax* kommt nur auf Ceylon vor. Durch die breite Elytrenbinde ist sie mit keiner anderen Art zu verwechseln. Die ebenfalls von Ceylon bekannte *laticollis* PIC ist anders gefärbt, der Prothorax ist schwarz und die Elytren haben keine dunkle Binde, sondern einen dunklen Hinterrand.

*biguttatus* GORH. Ann. Mag. Nat. Hist. 1880, ser 5, V, p. 213. Malabar (Autor). Mir lag die Art noch von folgenden Fundorten vor: Malabar Distr. Jaliparamba, Coimbatore, Cochin: Mooply Walley.

*contrarius* KLN. Ind. For. Rec. part VI, XIII, 1929, p. 257.

Mittelgrosse Art, 12 mm lang. Indien: Nilgiri Hills. Die Art ist mit keiner anderen zu vergleichen, am ähnlichsten ist noch *humeralis*, deren Prothorax aber schwarz gefärbt ist.

*dohertyi* PIC. Echange Nr. 320, 1911, p. 166.

Kleinere Art, 8 mm lang. Der Autor bezeichnet Malacca als Fundort. Mir lagen Stücke vor von Perak, Batang Padang, Jor Camp in 1800' Höhe. Die Art ist in der Ausfärbung etwas variabel. Durch Penisvergleich stellte ich noch ein sicheres Belegstück fest von Pahang, Gunong Tahan, Wray's Camp, 3300' Höhe, ferner lag mir ein Stück vor von Assam: Sadiya, von DOHERTY selbst gesammelt.

*densepilosus* KLN. Ind. For. Rec. part VI, XIII, 1929, p. 257.

Mittelgrosse Art, 10 mm lang. Das typische Stück stammt von Ceylon: Halupahani, Haldumulle, mir lag die Art auch von Südindien vor: Peermade, Travancore.



Fig. 2. — Geographische Verbreitung der Gattung *Lyropaeus* C. O. WAT.



*gorhami* PIC. Mél. I, 1911, p. 16.

Kleine Art, 7 mm lang. Indien ohne nähere Fundortangabe. Mir hat die Art nicht vorgelegen.

*optabilis* KLN. Journ. Fed. Malay Stat. Mus. XIII (2 u. 3), 1926, p. 196 Fig. 43.

Mittelgrosse Art, 11-13 mm lang. Malayische Halbinsel: Pahang, Cameron's Highlands, summit of Gunong Berumban, 6050', Rhododendron Hill, 5200', Tanah Ratah 4800', Perak, von DOHERTY gesammelt. Mir liegt ferner Material von Borneo vor: Mt. Matang, W. Sarawak, von BRYAND gesammelt, das ich von den Tieren der malayischen Halbinsel nicht unterscheiden kann. Die stark aufgebogene 1. Rippe auf den Elytren, die vor der Mitte plötzlich abbricht, ist allen Tieren gleich eigen. Das Vorkommen an beiden Lokalitäten wäre an sich nichts besonderes, bei dem lokalen Vorkommen der Lyciden ist die weite Verbreitung aber immerhin beachtenswert. Die einfarbig schwarze Art ist mit keiner anderen zu verwechseln.

*humeralis* n. sp. Abdomen, Kopf, Fühler und Prothorax rauchbraun, letzterer mit 2 unscharfen orangefarbenen Flecken, Elytren rauchbraun, Humerus bis ins vordere Drittel schmal, gelb, Beine mit hellen Hüften und gleich gefärbter Schenkelbasis. Fühler schlank, Glieder walzig, vom 3. ab nach vorn kürzer werdend. — Stirn tief eingedrückt, Fühlerbeulen robust, Mittelfurche tief. — Prothorax erheblich breiter als lang, Hinterecken spitz nach aussen vorgezogen, Punktierung grob und gross. — Schildchen zungenförmig. — Auf den Elytren sind die 1. und 2. Rippe am deutlichsten, verlöschen aber am Hinterrand fast ganz, die folgenden sind an beiden Seiten verkürzt und undeutlicher.

Länge: 6 mm, Breite (hum.): 1.5 mm circa.

Borneo: W. Sarawak, Mt. Matang, 16. — 30. XII. 13.

Sammler: G. E. BRYAND. 2 ♂ Typus im Brit. Mus.

*longipennis* PIC. Echange No. 320, 1911, p. 166.

Mittelgrosse Art, 10 mm lang. Java ohne nähere Angabe des Fundortes. Mir lag die Art nicht vor. Die Diagnose ist aber sehr ausführlich. Der Autor vergleicht sie mit *ritsemae* GORH., was auch sicher richtig ist. Die Differenzen sind im Bestimmungsschlüssel angegeben.

*ritsemae* GORH. Not. Leyd. Mus. IV, 1882, p. 101.

Mittelgrosse Art, 10.5 mm lang. Sumatra, Lebong (Autor). Ich besitze ein Belegstück von der Westküste Sumatras, Tandjunggadang in 1200 m Seehöhe.

*laticollis* PIC. Echange Nr. 423, 1926, p. 4.

Kleine Art, 7 mm lang. Ceylon ohne nähere Fundortangabe. Der Autor vergleicht sie mit *bicolor* PIC (siehe Bestimmungsschlüssel).

*bicolor* PIC. Echange 320, 1911, p. 166.

Kleinere Art, 8 mm lang. Java ohne nähere Fundortangabe. Mir lag die Art in grösserer Anzahl von Java mit folgenden zwei Fundorten vor: Depok; G. Slamet, Batoerraden. Die Variationsbreite scheint sehr gering zu sein, ich konnte keinerlei nennenswerte Abweichungen feststellen.



*binotatus* PIC. Echange No. 423, 1926, p. 4.

Mittelgrosse Art, 10 mm lang, Java ohne nähere Fundortangabe. Der Autor vergleicht die Art mit *waterhousei* und weist auf die verschiedene Ausfärbung des Prothorax hin. Die angegebenen Unterschiede trennen die Arten hinreichend.

*cinnamomi* KLN. Stett. Ent. Zeit. LXXXIX, 1930, p. 102.

Mittelgrosse Art, 13 mm lang. Indien: Nilgiri Hills. Die Art steht *aurantiacus* BOURG. am nächsten. Die hellen Farben sind aber dunkler, zimmetbraun, das Metasternum ist aufgehellert, der Kopf ist nur von den Fühlerbeulen ab hellfarbig, die 3 basalen Fühlerglieder ebenfalls. Das Abdomen ist einfarbig dunkelbraun.

*waterhousei* GORH. Not. Leyd. Mus. IV, 1882, p. 100.

Mittelgrosse Art, 10 mm lang. Sumatra, Lebong.

Die Gattung ist rein orientalisches. Von den 21 mir bekannten Arten sind festgestellt: In Indien 9, Ceylon 3, Assam 1, Cochin 2, malayische Halbinseln 2, Sumatra 2, Borneo 2, Java 3, Philippinen 1. Der lokale Charakter, der den Lyciden ganz allgemein eigen ist, prägt sich auch bei *Lyropaeus* aus. Nur bei einigen Arten ist die Verbreitung etwas grösser, so das Vorkommen indischer Arten in Cochin und der malayischen Art auf Borneo. Das Verbreitungszentrum dürfte in Indien gelegen haben, denn die Ausstrahlungen werden nach Osten spärlicher. Immerhin ist es beachtenswert, dass in Java noch 3 Arten aufgefunden worden sind. Die kleine beiliegende Skizze gibt eine Uebersicht über die Verbreitung.



## ZUR KENNTNIS DER ENTWICKLUNG VON *ATRACTOCERUS* *EMARGINATUS* CAST.

(Coleopt.-Lymexylonidae).

Von

Dr. L. FULMEK,

(Wien, Austria).

Während meines 5 jährigen Aufenthaltes in Medan (Deli, Sumatra O.K.) hatte ich öfters Gelegenheit, abends im Haus an die Lampe geflogene Exemplare von *Atractocerus emarginatus* CAST. zu erbeuten, eine Käferart aus der Familie der *Lymexylonidae*, welche durch ihr eher an geflügelte Termiten ("larongs") erinnerndes Äussere soviel des Interessanten in Körperbau u. Lebensweise darbietet, dass, — wie KARNY in seinem Aufsatz: „Zur Kenntnis der orientalischen *Atractocerus*-Arten (Col. *Lymex.*)“, — Treubia Vol. III. Livr. 1, 1922 Seite 6 bemerkt, — „ein eingehenderes Studium derselben — namentlich auch in biologischer Hinsicht — sehr wünschenswert wäre.“

Es waren darunter auch Weibchen in Legenot, welche nach dem Fang, in einer leeren Streichholzschachtel lebend über Nacht aufbewahrt, ohne weiteres ein Häufchen ihrer weissen, wachsglänzenden, länglichen Eier ablegten, mit einer etwas gelblich-glasigen, fadenziehenden Kittsubstanz aneinander und auf der Unterlage angeheftet.

Die Eier sind etwas walzenförmig verlängert, etwa  $2\frac{1}{4}$  -  $2\frac{1}{2}$  mm lang und  $\frac{1}{2}$  mm dick.

Bei einem Käferweibchen, welches am 1. September 1922 gefangen wurde und über Nacht Eier abgelegt hatte, haben diese nach einer Eidauer von 9 Tagen die ersten Larvenstadien geliefert. (Auch die leeren Eischalen sind noch stark klebrig; sie erscheinen glasig durchscheinend und strukturlos).

War hier somit der Anfang der Käferentwicklung gegeben, so kam ich am 30. Dezember 1925 durch Dr. HEUSSER von der AVROS-Proefstation bei Medan in Besitz eines *Hevea*-stammstückes von 23 cm Durchmesser, das im Holz Bohrgänge von 5 mm Weite aufwies und voll erwachsene *Lymexyloniden*larven beinhaltete. Im späterem Verlaufe der Beobachtung wurden auch Puppen des fraglichen Käfers gefunden, welche durch ihren Habitus bereits die Vermutung zulassen, dass es sich um eine *Atractocerus*-art handle; etliche am 1. Februar 1926 geschlüpfte Käfer aus dem beobachteten Zuchtmaterial ergaben nun ausser jedem Zweifel, dass *Atractocerus emarginatus* vorlag, womit also die Endglieder der Entwicklungskette gegeben waren.



Auf die Anlässe zur Vermutung, dass es sich bei *Atractocerus emarginatus* um einen Termito-philen handelt, will ich hier nicht eingehen, bemerke aber nur, dass nach dem gewonnenen Eindruck bei der Larvenuntersuchung ein echter Holzbohrer vorliegen dürfte und dass meines Wissens auch in den Fed. Malay States (malayischen Staaten von Malakka) das Vorkommen von *Atractocerus*-larven in "rubber trunks" bereits beobachtet worden ist.

Ei larve: die aus dem Ei geschlüpfte Larve ist ungefähr 2.5 mm lang und 0.5-0.6 mm breit, der kapuzenförmige, mächtig entwickelte Prothorax etwas breiter (0.68 mm); beinweiss, mit rotbraunen bis schwarzbraunen Chitinisierungen; auffallend lang behaart, die Haare am Thorax und am Hinterleibsende am längsten.

Kopfkapsel honigbraun, mit 2 hellen Linien vom Scheitel zu den Fühlern (Frontolateralsuturen) und einer ebensolchen hellen Linie seitlich am Epicranium. Auge in Form von 5 Ocellen, knapp ober den Fühlern vorhanden und zwar in einer oberen 3-er Gruppe und 2-er Gruppe dicht darunter angeordnet. Fühler kurz, 3gliedrig, das Basalglied mit einem Sinneszapfen, das 2. Glied mit langer Borste. Mandibeln schwarzbraun, mächtig entwickelt; Maxillartaster und Unterlippe hell, beinweiss. Kinn sehr kurz, stäbchensaumartig beborstet; Kehle vor dem ersten Beinpaar, dicht und lang beborstet.

Prothorax, wulstartig, als Kapuze entwickelt, nach hinten verbreitert; an den Seiten, sowie an seinem Vorderrand oberseits und in der Mitte, nach hinten etwas ausgezogen, eine aus zahlreichen und dicht gestellten Dornspitzchen übersäte Kriechschwiele entwickelt. Am Hinterrand des Prothorax vier lange Borstenhaare. Aehnliche, aber viel kleinere Kriechschwiele mit dornspitziger Chitinskulptur vorn an den Seiten von Meso- u. Metathorax, während die Tergite, nicht nur am Thorax, sondern auch am Abdomen, je 2 in der Mittellinie des Körpers hell von einander geschiedene, dunkelbraune, grosse, quere Chitinplatten tragen; diese sind am grössten und stärksten entwickelt am Mesothorax und werden auf den folgenden Segmenten immer schwächer; nichtsdestoweniger aber sind sie an ihrem Vorderrande stets scharf dunkler konturiert. Mesothorax, wie der Prothorax, noch mit sehr langen Borstenhaaren u. zw. 3 jederseits von der Längsmittellinie des Körpers, am Metathorax hingegen nur an den Seiten je zwei lange Borstenhaare (davon das obere länger), während die beiden mittleren Borstenhaare dorsal, viel kürzer sind; davor stehen am Metathorax, hinter seinen dunkeln, queren Tergitplatten, jederseits der Medianen, je 4 winzige, dunkle Dornzähnen in einer Querreihe, welche schräg aufwärts und nach hinten gerichtet sind.

Auf den folgenden Segmenten der Körpermitte finden sich derartige, nach hinten gerichtete Dornzähnen in Form eines mehrreihigen (3-5) Querbandes auf der Kuppe und auf der abfallenden Hinterhälfte jedes Tergites bis zum 5. Abdominalsegment inclusive; am Hinterrand dieses Dörnchengürtels jeweils 4 kurze Dorsalborsten, die nach aussen, noch oberhalb des Stigmas von je einem langen Borstenhaar flankiert werden. Am 6. Tergit des Abdomens nur mehr eine einzige Dornspitzenquerreihe, dafür 2 lange Borstenhaare, mit kurzen



alternierend jederseits; am 7. u. 8. Tergit, als hintere Begrenzung der hier in der Mitte ungeteilt querdurchlaufenden dunklen Tergitplatten, je eine Querreihe kurzer Stachelborsten in Form eines nach hinten gerichteten Kammes, bei dem in der Medianen doch noch eine feine helle Teilung mehr oder minder angedeutet ist; Dorsaldecke des Endsegmentes schwarzbraun, am Hinterrand in eine 2-spitzige Zange verlängert, deren Spitzen in Seitenansicht deutlich nach oben und vorwärts (orad) gekrümmt sind. Diese Art Afterschildchen sehr kurz, stäbchen-

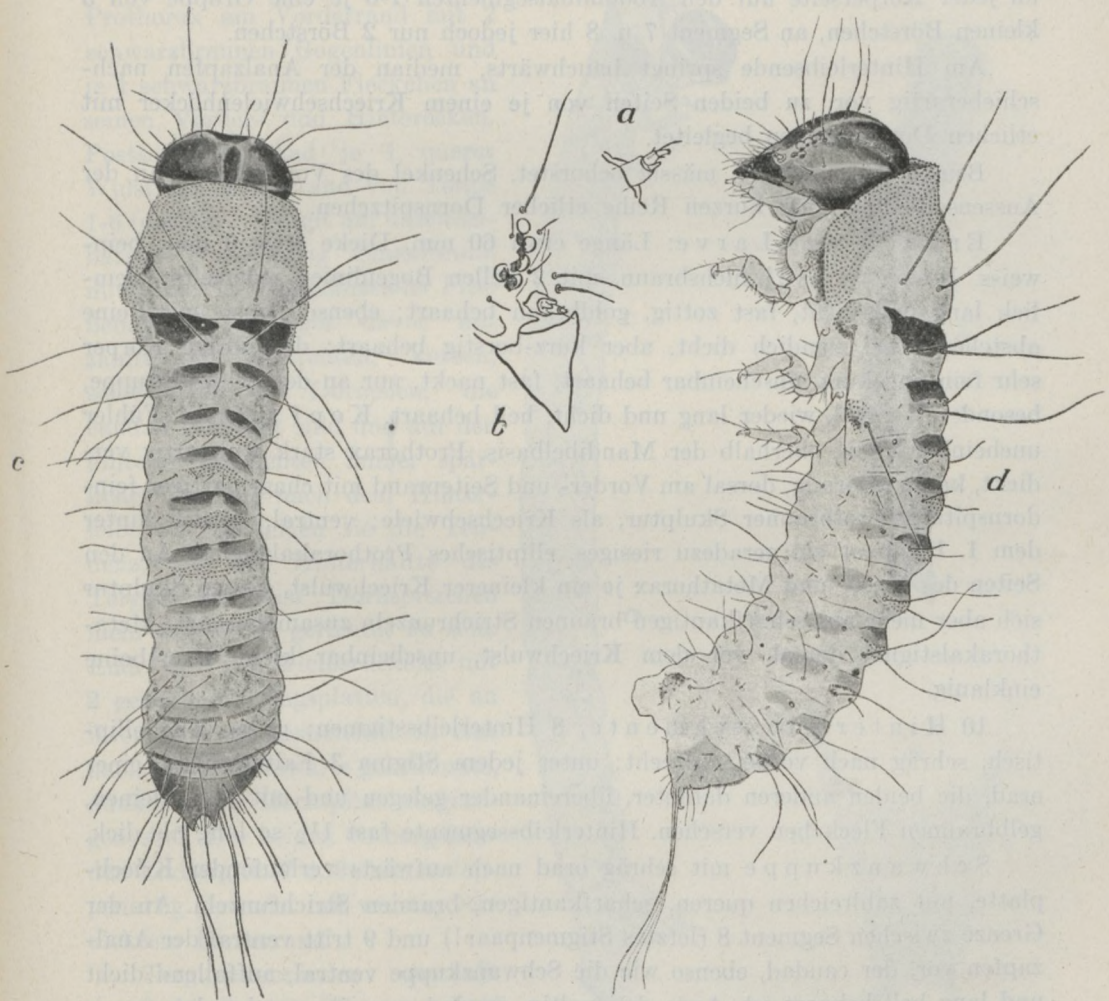


Fig. 1. — Eilarve vom *Atractocerus emarginatus* CAST.

*a* Fühler, *b* Ocellengruppe mit Fühler und Mandibel. — Bei ca. 70fach. Vergr. *c* Die Larve von oben, *d* von der Seite. — Bei 35facher Vergr.

saumartig behaart, dazwischen längere Borsten verstreut und 4 besonders lange Borstenhaare an der Endzangenbasis.

In der Umgebung der Hinterleibsstigmata oberhalb, schräg caudad orientiert,



je ein sehr kurzes Börstchen; ventral und caudal vom Stigma je ein Borstenpaar, bei welchem die obere Borste haarartig lang, die untere aber sehr kurz ist. Die fast kreisrunden Stigmen liegen am Dorsalrande eines schwach ange-dunkelten Seitenwulstes, der dorsoventral orientiert ist.

Auf der Ventralseite, längs der Mittellinie, jederseits je 2 lange Borstenhaare, von welchen das äussere bedeutend länger als das innenstehende ist. Zwischen diesen letzteren und dem dunklen Seitenwulst (unterhalb des Stigmas) an jeder Körperseite auf den Abdominalsegmenten 1-6 je eine Gruppe von 3 kleinen Börstchen, an Segment 7 u. 8 hier jedoch nur 2 Börstchen.

Am Hinterleibsende springt bauchwärts, median der Analzapfen nach-schieberartig vor, zu beiden Seiten von je einem Kriechschwielenhöcker mit etlichen Dornspitzchen begleitet.

Brustbeine einklauig, mässig beborstet. Schenkel des Vorderbeines an der Aussenseite mit einer kurzen Reihe etlicher Dornspitzchen.

Erwachsene Larve: Länge etwa 60 mm, Dicke etwa 5 mm; beinweiss. Kopfkapsel fuchsbraun, mit 2 hellen Bogenlinien jederseits; ziemlich lang und dicht, fast zottig, goldbraun behaart; ebenso Brust und Beine abstehend und ziemlich dicht, aber kurz-borstig behaart; der übrige Körper sehr fein und kurz, unscheinbar behaart, fast nackt, nur an der Schwanzkuppe, besonders ventral, wieder lang und dicht, hell behaart. Kopf augenlos. Fühler unscheinbar klein, oberhalb der Mandibelbasis. Prothorax stark wulstartig verdickt, kapuzenförmig, dorsal am Vorder- und Seitenrand mit chagrinartiger feindornspitziger, rotbrauner Skulptur, als Kriechschwiele; ventral, seitlich hinter dem 1. Beinpaar ein geradezu riesiges, elliptisches Prothorakalstigma. An den Seiten des Meso- und Metathorax je ein kleinerer Kriechwulst, dessen Skulptur sich aber mehr aus scharfkantigen braunen Strichrunzeln zusammensetzt. Metathorakalstigma dorsal, vor dem Kriechwulst, unscheinbar klein. Brustbeine einklauig.

10 Hinterleibssegmente; 8 Hinterleibsstigmen: gross, lang elliptisch, schräg nach vorne, aufrecht; unter jedem Stigma 3 Faltenwülste, einer orad, die beiden anderen dahinter, übereinander gelegen und mit je 1 kleinen, gelbbraunen Fleckchen versehen. Hinterleibssegmente fast  $1\frac{1}{2}$  so lang als dick.

Schwanzkuppe mit schräg orad nach aufwärts verlaufender Kriechplatte, mit zahlreichen queren, scharfkantigen, braunen Strichrunzeln. An der Grenze zwischen Segment 8 (letztes Stigmenpaar!) und 9 tritt ventral der Analzapfen vor, der caudad, ebenso wie die Schwanzkuppe ventral, auffallend dicht und lang hell behaart ist. Anus dreispaltig, caudad von einem schmalen, grau-braunen Schildchen überdacht. Analzapfen zu beiden Seiten mit je 1 kleinen, braunen Kriechschwiele (von ähnlicher Struktur wie an der Schwanzkuppe und an den Hinterbrustseiten); die Haut in der Umgebung mit fein chagrinartiger Skulptur. — Im Habitus der Larve des europäischen *Lymexylon navale* L. übrigens ähnlich.

Puppe: Länge 35-37 mm, Dicke 4-5 mm; beinweiss; Kopf- und Brustab-



schnitt dunkelgrau. Flügelscheiden, Beine, Fühler und die mächtig geschwollenen, ventral querverrippten Maxillartaster mehr hellgrau bis dunkel; kahl.

Kopfkapsel heller graugelb, goldbraun behaart; auch Prothorax, Schildchen und Tergite des Abdomens deutlich, jedoch viel sparsamer behaart; Hinterleibsende 2spitzig, ebenfalls etwas länger und dichter goldbraun behaart. Behaarung der Kopfkapsel, besonders an den Seiten deutlich in bandstreifenartigen Haarspuren angeordnet. Augen gross, mit dunkler braunem Fleck inmitten des kahlen Fazettenfeldes.

Prothorax am Vorderrand mit 2 schwarzbraunen Bogenlinien und je 1 schwarzbraunen Fleckchen an seinen Vorder- und Hinterecken. Postscutellum und je 1 querer Wulst am Hinterrand von Tergit 1-6 (der am 1. Tergit am unscheinbarsten!) samtartig dunkelbraun mit kurzer messingglänzender Filzbehaarung; Tergite davor mit zahlreichen verstreuten, kurzen, schwarzbraunen Dörnchen, die caudad gerichtet sind und auf den hinteren Segmenten immer spärlicher werden; nach dem Hinterleibsende zu zeigen sie die Tendenz, auf der Hinterhälfte des Tergits mit den Dornspitzchen mehr kopfwärts gerichtet zu sein. Ende des Hinterleibsrückens mit 2 gewölbten Längsplatten, die an ihrer hinteren Aussenecke in eine nach ab- und einwärts gekrümmte, dunkelbraune Hornspitze ausgezogen sind. Die beiden vorhergehenden Endtergite (7 u. 8) hinten lappenartig gerundet mit wulstig verdicktem Hinterrand.

Tergitseitenränder oberhalb des 2. bis letzten Stigmas scharf gekantet dunkel, mit je einem scharfspitzigen Dorn vor der Mitte. Die jederseits 7 sichtbaren Stigmen gross, schmall, langelliptisch, schräg aufrechtstehend. Ventral von 2.-6. sichtbaren Stigma jederseits ein nasenartiger, nach unten offener Faltenwulst mit schwarzbrauner Bogen-

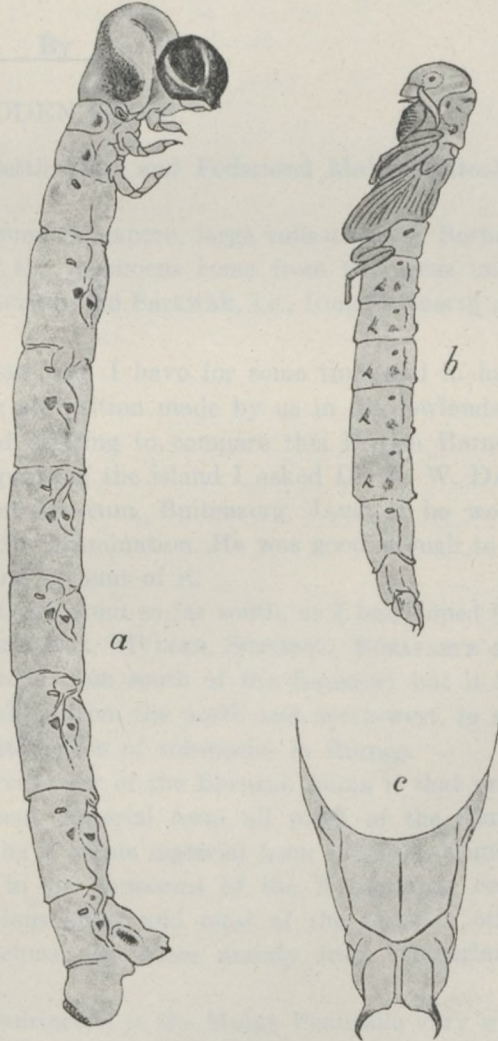
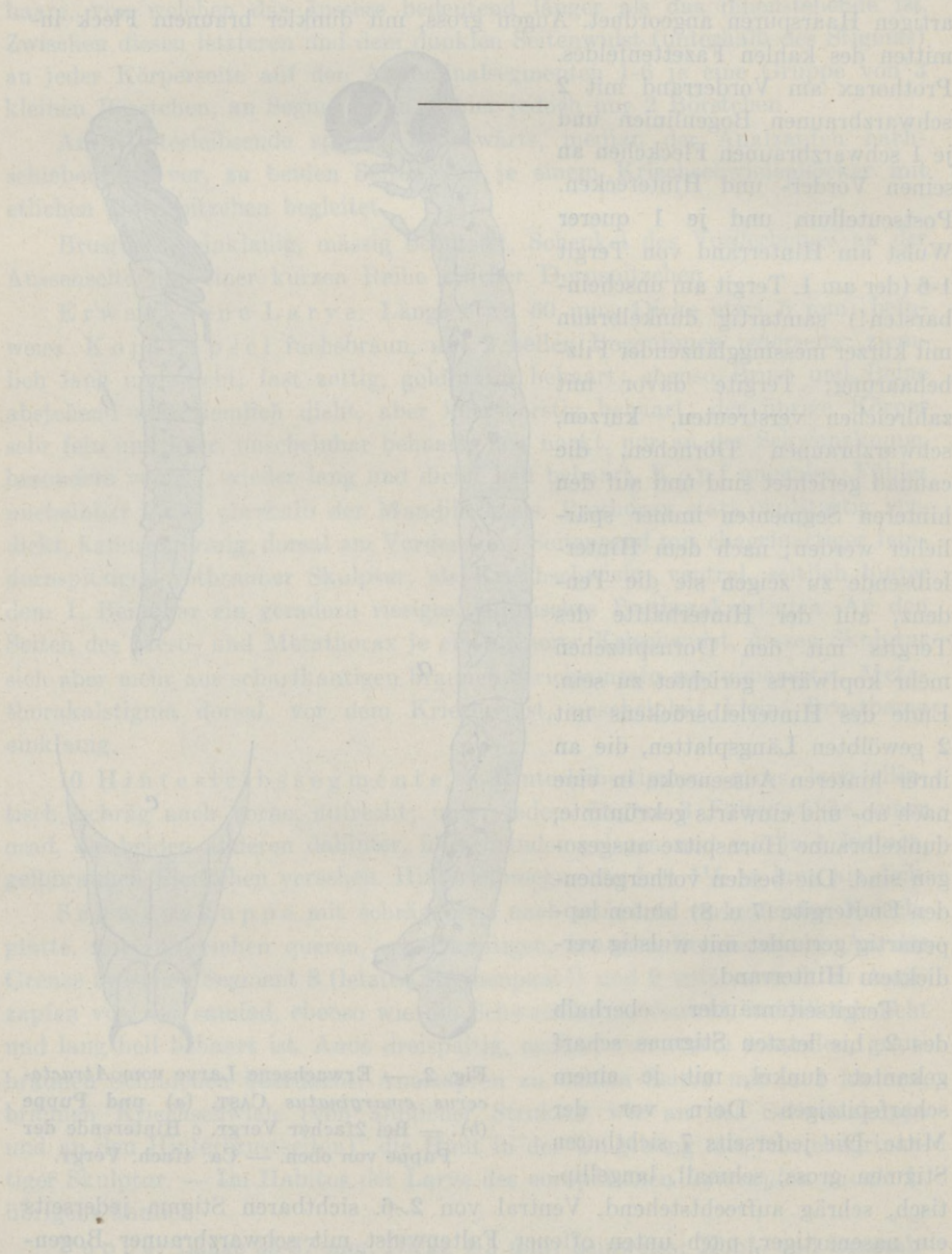


Fig. 2. — Erwachsene Larve vom *Atractocerus emarginatus* CAST. (a) und Puppe (b). — Bei 2facher Vergr. c Hinterende der Puppe von oben. — Ca. 4fach. Vergr.



linie nach vorne begrenzt und caudad offen; am nachfolgenden Segment hier jederseits nur eine schwarzbraune Längsfalte. Ausserdem, etwas unterhalb der Stigmenlinie, an jedem Segment vom Hinterrand ebensoweit entfernt als das zugehörige Stigma vom Vorderrand, je ein brauner Fleck. Alle Zeichnungen am Segment mit dem vorletzten Stigma verwaschener, am Segment mit dem letzten Stigma nahezu fehlend.





**AN ACCOUNT OF THE BORNEAN BIRDS IN THE ZOOLOGICAL  
MUSEUM, BUITENZORG, WITH THE DESCRIPTION  
ON A NEW RACE.**

By

C. BODEN KLOSS

(Director of Museums, Straits Settlements and Federated Malay States).

There are in the Raffles Museum, Singapore, large collections of Bornean birds, but ninety-nine per cent of the specimens come from the areas under British protection: British North Borneo and Sarawak, i.e., from the north and north-west of the island.

My colleague, Mr. F. N. CHASEN, and I have for some time had in hand for publication a report on a large acquisition made by us in the lowlands of British North Borneo in 1927: and desiring to compare this British Bornean material with material from other parts of the island I asked Dr. K. W. DAMMERMAN, Director of the Zoological Museum, Buitenzorg, Java, if he would submit his Bornean bird collection for examination. He was good enough to do this and I have written the following account of it.

The collection was not as large, nor from so far south, as I had hoped (for most of the forms described by TEMMINCK, MÜLLER, SCHLEGEL, BONAPARTE and more recent Dutch ornithologists came from south of the Equator) but it has helped, by direct comparison with skins from the north and north-west, to add a little to our knowledge of the distribution of subspecies in Borneo.

A difficulty in obtaining a correct view of the Bornean fauna is that practically no museums possess sufficient material from all parts of the island. British museums, taken altogether, have ample material from those parts under British protection, the collections in the museums of the Netherlands come practically from their own possessions only; and most of the skins in other continental and in American museums also come mainly from Netherlands Borneo.

Excluding the mountain birds, subspecies in the Malay Peninsula vary with latitude, in Java with longitude: but in Borneo neither of these artificial features are uniformly accompanied by geographical variation. The island is much larger than either the Peninsula or Java and, being much more rectangular in shape, is affected by variation both latitudinally and longitudinally. We find races differing sometimes north and south and sometimes east and west; sometimes there is no difference at all and sometimes a local form seems to be



confined to a small area of the island. Until the faunas of the various quarters have been actually compared with each other we shall lack a really sound knowledge of the fauna of Borneo as a whole. For want of sufficient material it is at present out of the power of any one institution to make a satisfactory comparison.

The latest list of the Birds of Borneo was drawn up by the late Dr. J. C. MOULTON, Director of the Raffles Museum (vide Journal, Straits Branch of the Royal Asiatic Society, No. 67, 1914, pp. 125-176. Singapore). It was, however, largely an uncritical compilation and suffers somewhat on that account. It is accompanied by a most useful Bibliography of ornithological papers (pp. 177-191).

In our account of North Bornean birds, which will be found in the Bulletin of the Raffles Museum, No. 4 (which might be read with this paper) Mr. CHASEN and I have commented, often at considerable length, on species and races so I have not thought it necessary to incorporate many critical remarks here.

With the exception of few odd specimens (CARL BOCK, VORDERMANN, etc.) the material in Buitenzorg comes from four localities:

1. North-west Borneo. From the Lawas River, Brunei. Collected by Mr. J. M. DUMAS in 1900 (Referred to as "Lawas River").
2. North-east Borneo. From the boundary between Netherlands Borneo and British North Borneo. Collected by the Dutch party of the Boundary Commission in 1912. (Referred to as "Northern Boundary").
3. Central East Borneo. From the lower Mahakkam or Koetai River (a few skins only) and along its tributary, the Telen River, coming from the north; at Moeara Antjaloeng (lat.  $0^{\circ} 26' N.$ ), Moeara Marah, Moeara Wahau, Long Poetoes, Long Huet, Long Temelen, Long Liah Leng, Long Petah (lat.  $1^{\circ} 34' N.$ ) and at Punt D, 1172 metres, about eight kilometres above Long Petah in the hills where rises the Telen. Collected by Mr. H. C. SIEBERS in 1925 <sup>1)</sup> (when he was ornithologist in the Zoological Museum, Buitenzorg) and forming the greater part of the material submitted. (Referred to as "Telen River", unless specimens come from one station only or require particular mention, and "Punt D, 1172 metres"). Though various collections of birds have been made more recently in Netherlands East Borneo (ABBOTT, RAVEN, LUMHOLTZ) and local races have been described from the material obtained, the last collection to have been dealt with as a whole was that of NIEUWENHUIS described by FINSCH, during the binomial era, in Notes from the Leyden Museum, XXI, 1905, pp. 1-154.
4. South-west Borneo. From the Melawi River, a southern tributary of the Kapuas River. Collected by Mr. A. BLANCHEMANCHE in 1924-5. (Referred to as "Melawi River").

<sup>1)</sup> vide „Midden-Oost Borneo Expeditie 1925" Uitgave van het Indisch Comité voor Wetenschappelijke Onderzoekingen. Batavia, Kolff & Co., 1927.



## Systematic

*Alophoixus phaeocephalus medius* subsp. nov. E. Borneo.

## PHASIANIDAE.

**Arborophila hyperythra hyperythra** (SHARPE).

1 sex inc., West Borneo.

Wing 135 mm. Forehead and crown barred with rufous.

**Haematortyx sanguineiceps** SHARPE.

1 sex inc., Borneo (CARL BOCK).

Wing 165 mm.

**Rollulus roulroul** (SCOP.)

1 ♂ Lawas River; 8 ♂, 4 ♀ Northern Boundary; 3 ♂, 2 ♀, Telen River; 2 ♂, 1 ♀, Melawi River.

Wings: ♂ 136, 139, 140, 141, 141, 142, 142, 143, 143, 144, 145, 146, 148, 148, 151; ♀ 134, 136, 138, 142, 142, 142, 145 mm. The extremes come from the Boundary.

Two male pullets from Long Petah are chestnut, blackish on the rump, palest on the abdomen.

**Excalfactoria chinensis lineata** (SCOP.).

1 ♂ Lawas River; 1 ♀ "Borneo".

Wings: ♂ 74; ♀ 72 mm.

The male is inseparable from Malayan males. The female, like examples from Sarawak, is darker and more freely and heavily barred below than Malayan females, resembling *lineata* of the Philippines. Bornean birds have been separated (*caerulescens* HACHISUKA) without comparison with those of Java (*E. c. palmeri* RILEY), which are also described as darker than Malayan birds.

**Lophura ignita** (SHAW and NODDER) *vide* O.-GRANT, Cat. Birds B.M., XXII, 1893, p. 288.

*Lophura nobilis* (SCLATER) *vide* BÜTTIKOFER, Notes Leyden Mus. XVII, 1896, p. 175.

1 ♂ Marah; 1 ♀ Melawi River; 1 ♀ Sintang, West Borneo (OUWENS).

Wings: ♂ 270; ♀ 245, 255 mm.

**Lobophasianus bulweri** SHARPE.

1 ♂ Punt D, 1172 metres; 1 ♂ "Borneo" (CARL BOCK).

Wings: 265, 267 mm.

**Argusianus argus grayi** (ELLIOT).

1 ♀ Long Petah. Wing 395 mm.



## TRERONIDAE.

**Butreron capellei** (TEMME.)

2 ♀ Northern Boundary. Wings: 191, 192 mm.

OBERHOLSER has named a bird from Klumpang Bay, S.E. Borneo, *B. c. messophora*. These two females and other birds from British North Borneo are not separable from Malayan birds (*magnirostris* STRICKLAND; but we have been unable to compare any of them with topotypes from Java where the bird now seems to be very scarce.

**Treron fulvicollis fulvicollis** (WAGL.)

1 ♂ Bandjermasin (VORDERMANN). Wing 138 mm.

In the northern half of Sarawak and in British North Borneo *T. f. baramensis* MEYER, is found.

**Treron vernans griseicapilla** SCHLEG.

1 ♂ Northern Boundary. Wing 142 mm.

In the S. E. and South of Borneo birds are, or closely approach, the East Javan form *T. v. purpurea* (GM.).

**Treron olax** (TEMME.)

1 ♀, Lawas River; 2 ♂, Northern Boundary. Wings: ♂ 115, 122; ♀ 120 mm.

OBERHOLSER has named a bird from N. E. Borneo, *T. o. arismicra*. Our considerable material shows no character to separate it from the typical form.

**Ptilinopus jambu** (GM.)

3 ♂, Northern Boundary; 1 ♀ Long Petah. Wings: ♂ 137, 138, 145; ♀ 136.

**Ducula aenea aenea** (LINN.)

2 ♂, 1 ♀, Northern Boundary. Wings: ♂ 230, 240; ♀ 232 mm.

**Ducula badia capistrata** (TEMME.)

1 ♀, Northern Boundary. Wing 233 mm.

SIEBERS (Treubia, XI, 1929, p. 149) upholds TEMMINCK's name for Javan and Bornean birds because of a smaller apical tail-band. The difference is of doubtful value and will probably disappear with more material.

## PERISTERIDAE.

**Chalcophaps indica indica** (LINN.)

2 ♂, 1 ♀, Northern Boundary. Wings: ♂ 138 (imm.), 142; ♀ 131 (imm.).

## RALLIDAE.

**Amaurornis phoenicura javana** (HORSE.)

2 sex inc., Lawas River. Wings: 112 (imm.), 137 mm.



## CHARADRIIDAE.

**Charadrius dubius curonicus**, GM.

1 ♀, Telen River. Wing 114 mm.

## ARDEIDAE.

**Bubulcus ibis coromandus** (BODD.)

1 ♀, Northern Boundary. Wing 235 mm.

**Ixobrychus eurhythmus** (SWINHOE).

1 ♀ imm., Northern Boundary. Wing 143 mm.

*I. eurhythmus* is the same size as, and very closely related to *I. cinnamomea* (if not a subspecies of it) from which it can apparently be distinguished at all ages by having the remiges and tail greyish or brownish black instead of cinnamon.

The plumage appears to vary considerably with age, younger birds having much of the upper surface spotted with white or pale buff, the wing-coverts variegated with large chestnut patches (instead of being plain olive-buff) and the foreneck and breast more freely streaked with brown.

The present example is in the stage of MEYER and WIGLESWORTH's lower coloured figure of *Ardetta eurhythmia* (Birds of Celebes, pl. XLV): the upper figure being that of the adult. We have examples of both stages before us from the Federated Malay States whence it has not yet been recorded.

This bird and *I. cinnamomea* both differ from other members of the genus in having the tibia naked above, instead of feathered nearly to, the tibio-tarsal articulation; while the basal joint of the middle toe is as long as the second instead of being much shorter. STEJNEGER has proposed for it the genus *Nannocnus*.

## ANHINGIDAE.

**Anhinga rufa melanogaster** FORST.

1 sex inc. Koetai, Central East Borneo (CARL BOCK).

## FALCONIDAE.

**Microhierax fringillarius** (DRAP.)

1 ♀ Telen River. Wing 102 mm.

In North Borneo occurs *M. latifrons* SHARPE.

**Spizaetus cirrhatus limnaetus** (HORSF.)

1 ♂, Northern Boundary. Wing 398 mm.

**Ichthyophaga ichthyaetus ichthyaetus** (HORSF.)

1 sex inc., Borneo (CARL BOCK). Wing 460 mm.



## BUBONIDAE.

**Otus bakkamoena lempiji** (HORSF.).

1 ♀, Marah. Wing 145 mm.

**Glaucidium brodiei sylvaticum** (BP.).

1 sex inc., Kilam Bolset (BUYS, coll.). Wing 94 mm.

**Phodilus badius badius** (HORSF.).

1 ♀, Northern Boundary. Wing 190 mm.

## PSITTACIDAE.

**Psittacula longicauda longicauda** (BODD.).

1 ♂ Marah. Wing 152 mm.

**Psittinus cyanurus cyanurus** (FORST.).

2 ♂, Melawi River. Wings 114, 115 mm.

**Coryllis galgulus galgulus** (LINN.).

2 ♂ 1 ♀, Lawas River; 2 ♂ 2 ♀, Northern Boundary; 2 ♂ Mocara Antjaloeng;  
2 ♂ Melawi River.

Wings: ♂ 80, 80, 80, 81, 82, 83, 83. ♀ 75, 81, 82 mm.

## PODARGIDAE.

**Batrachostomus stellatus** (GOULD).

1 ♀ Northern Boundary. Wing 120 mm.

**Batrachostomus affinis** BLYTH.

1 ♀ Borneo. Wing 128 mm.

## CORACIIDAE.

**Eurystomus orientalis orientalis** (LINN.).

1 ♀ Melawi River. Wing 186 mm.

**Eurystomus orientalis calonyx** HODGS.

1 ♀ Koetai (CARL BOCK), 1 ♂ Mocara Wahau; 1 ♀ Melawi River. Wings:  
♂ 184, 202. ♀ 187.

## ALCEDINIDAE.

**Rhâmphalcyon capensis javana** (BODD.).

2 ♂ 1 ♀ Telen River. Wings: ♂ 137, 139 (imp.). ♀ 143 mm.

**Alcedo meninting verreauxi** DE LA BERGE.

1 ♂ (ear-coverts rusty) 1 ♀ (ear-coverts blue) Teien River.

Wings: ♂ 62. ♀ 62 mm.

Birds of Borneo, Sumatra and the Malay Peninsula are smaller and of a darker blue than the typical Javanese form. The colour of the ear-coverts varies considerably in the present race.



**Alcedo euryzona** TEMM.

1 ♀ Telen River. Wing 79 mm.

Lores rufous, lower eyelids partly rufous. Back bright turquoise, richest on mantle and tail-coverts.

**Ceyx erithacus motleyi** CHASEN & KLOSS, Journ. f. Ornith., 1929, Bd. 2, p. 106 (Sandakan).

2 ♂ 2 ♀ Telen River (paratypes)

Wings: ♂ 55, 59; ♀ 61, 61 mm.

**Halcyon pileata** (BODD.)

1 ♀ Northern Boundary; 3 ♂ Telen River.

Wings: ♂ 123, 124, 128; ♀ 124 mm.

**Halcyon sancta sancta** VIG. & HORSE.

1 ♂ Moeara Wahau. Wing 92 mm.

**Halcyon concreta borneana** CHASEN & KLOSS, Bull. Raffles Mus. No. 4, 1930, p. 24. North Borneo.

4 ♂, 2 ♀ Telen River.

Wings: ♂ 111, 112, 114, 115; ♀ 118, 118 mm.

Larger than the typical Sumatran form which also occurs in the Malay Peninsula.

**Lacedo pulchella melanops** (BP.)

1 ♀ Marah. Wing 83 mm.

This race has a curious distribution: — Borneo and Banka Island!

## BUCEROTIDAE.

**Buceros rhinoceros borneoensis** SCHLEG. & MÜLL.

4 ♂, 5 ♀ Northern Boundary.

*Buceros rhinoceros* LINN. has for habitat "India" where, in the modern sense, the species does not occur. We, therefore select Malacca for *terra typica* as other localities in the range have been eliminated by having local races proposed for them, viz., *sumatranus* S. & M., for Sumatra; *borneoensis* S. & M. for Borneo; *sylvestris* VIEILL., for Java.

Birds from the Doeson, or Barito River, S. E. Borneo, were separated as being small, with a small casque:

Wing 430, casque 110-120 mm. These dimensions are apparently those of females.

Though our Malayan series is small (4 ♂, 2 ♀ only) the dimensions of males are so much larger than those of a series of eight adult males from North-west, North and East Borneo that it is necessary to recognize a subspecies for the island.

Wings:	Malayan males 475-503.	Bornean males 425-475.
Casques:	" " 154-214.	" " 128-163.
Bills from gape:	" " 250-280.	" " 215-257.



On our series of females (7 Bornean) the differences are not perceptible:

Wings:	Malayan 420-448.	Bornean 420-450.
Casques:	„ 132-145.	„ 117-143.
Bills from gape:	„ 210-251.	„ 205-233.

According to SCHLEGEL and MÜLLER Sumatran birds are large: — wing 510, casque 180-190 mm. They may not be separable from the typical form. We have only a pair from Siak:

	♂	♀
Wing:	483	460.
Casque:	167	120.
Bill from gape:	253	224.

**Anorrhinus galeritus** (TEMM.)

2 ♂, 5 ♀, Northern Boundary.

Wings: ♂ 350, 350: ♀ 318, 318, 325, 338, 340 mm.

In this bird the bill seems to be black in adult males, black and white in adult females, and white in juveniles of both sexes.

**Anthracosceros coronatus convexus** (TEMM.).

1 ♂ 1 ♀, Northern Boundary.

Wings: ♂ 315: ♀ 268 (imm.?) mm.

**Anthracosceros malayanus** (RAFFLES).

1 ♂, 1 ♀ Northern Boundary.

Wings: ♂ 316: ♀ 265 (imm.?) mm.

The first is the adult male of the Catalogue of Birds (XVII, p. 369) except that the superciliary stripe is grey instead of white; and except for this feature it is also the large adult male *malayanus* figured and described in ELLIOT's "Monograph of the Bucerotidae".

The description of "less mature specimens" in the Catalogue applies to the female which, also, has the eyebrow grey: except for this last character it is the female *malayanus* described by ELLIOT and figured on the right of his plate; the *nigrirostris* of BLYTH, and of SALVADORI. We intend to deal later with the status of these birds.

**Rhinoplax vigil** (FORST.)

1 ♂ 2 ♀ Northern Boundary. Wings: ♂ 480: ♀ 420, 450 mm.

MEROPIDAE.

**Nyctiornis amicta** (TEMM.)

2 ♀ Long Petah, 3 ♀ Melawi River.

Wings: 121 (imm.), 122, 126, 126, 128 mm.

CAPRIMULGIDAE.

**Lyncornis temmincki** GOULD.

1 ♂ Melawi River. Wing 203 mm.



## MICROPODIDAE.

**Cypsiurus batasiensis infumatus** (SCLATER).

1 ♀ Melawi River. Wing 111 mm.

**Hirundapus leucopygialis** (BLYTH).

2 ♂, 4 ♀, Moeara Antjaloeng.

Wings: ♂ 115, 120: ♀ 118, 122, 123, 126 mm.

**Collocalia brevirostris lowi** (SHARPE).

1 ♂ 2 ♀, Telen River. Wings: ♂ 131: ♀ 117 (imp.), 124 mm.

We place these specimens under *C. b. lowi* as they appear to agree with STRESEMANN's description of that race rather than with his *C. b. tichelmani* from Tamaloeang, S. E. Borneo (Orn. Monats. XXXIV, 1926, p. 104).

**Collocalia esculenta cyanoptila** OBERH.

1 ♀ Moeara Antjaloeng. Wing 102 mm.

**Hemiprocne comata comata** (TEMM.)

1 ♂ 1 ♀ Telen River. Wings: ♂ 127. ♀ 128 mm.

## TROGONIDAE.

**Pyrotrogon diardi diardi** (TEMM.)

2 ♀ Northern Boundary. Wings: 138, 142 mm.

**Pyrotrogon fasciatus kasumba** (RAFFL.)

1 ♂, 1 ♀ Northern Boundary; 1 ♂ 1 ♀ Telen River.

Wings: ♂ 132, 135 (imm.): ♀ 136, 139 mm.

*P. whiteheadi*, from Mt. Kinabalu may be a very distinct mountain form of this species, resembling the typical race of Ceylon in its grey breast. Females of the species do not differ greatly from each other: the males may be distinguished as follows: —

## A. Foreneck and breast grey.

a. Crown and nape grey: a white breast-band.

*f. fasciatus*. Ceylon.

b. Crown and nape scarlet: no breast-band.

*f. whiteheadi*. Kinabalu,

Dulit and Mulu Mts, N. Borneo.

## B. Foreneck and breast black or blackish: a white breast-band.

a. A scarlet nuchal collar ..... *f. kasumba*. Sumatra,  
Malay Peninsula and Borneo.

b. No nuchal collar ..... *f. malabaricus*. S. India,  
North to Western Bengal.

**Pyrotrogon ororphaeus vidua** (O. GRANT).

1 ♂ Punt D, 1172 metres. Wing 107 mm.



**Pyrotrogon duvauceli** (TEMME.)

3 ♀ Northern Boundary; 2 ♂ Long Petah; 1 ♂ 2 ♀ Melawi River.

Wings: ♂ 102, 103, 107; ♀ 101, 102, 103, 108, 110 mm.

## CUCULIDAE.

**Surniculus lugubris brachyurus** STRESEM.

3 ♀ Telen River. Wings: 113, 117, 121 mm.

**Hierococcyx fugax fugax** (HORSF.).

1 ♂ ad., 1 ♂ imm., Long Petah; 1 sex inc. imm. „Borneo.”

Wings 163, 167, 168 mm.

Bills, tip to nostril, 17, 17, 18 mm.

This is the local breeding race; the two other races of the species, *H. f. nasicolor* (Hodgs. in Blyth) which breeds in Northern India and Southern China, and *H. f. hyperythrus* (GOULD) breeding in N. E. Asia and Japan, visit Borneo: the last having been recorded from the north and east of the island only. It is the largest form and is further distinguished from the others by having the dark bands of the tail bordered on their lower edges by indefinite pale brown stripes; it has the breast uniformly rufous as a rule in adults. *H. f. nasicolor* differs from *H. f. fugax* in having a shorter bill and the penultimate dark and light bars of the tail much narrower (cf. fig. 8, a, b, of SIEBERS, Treubia, VII, Suppl., 1930, p. 273).

**Cacomantis merulinus**.

1 ♂ Lawas River. Wing 101 mm.

If different from the Philippine bird, then *C. m. threnodes* CAB. & HEINE.

**Chalcites xanthorhynchus** (Subsp.).

1 ♂ ad. "Borneo". Two and three outer tail feathers with white terminal spots.

1 ♂ subad. Telen River. Three outer pairs with white terminal spots.

1 ♀ ad. Melawi River. Three outer pairs with white terminal spots.

These specimens seem on account of the tail pattern nearer to Philippine birds which have been named *amethystinus* by VIGORS, than to the typical Javanese form.

**Chalcites malayanus malayanus** (RAFFLES).

1 ♂ Telen River. Wing 92 mm.

[*Cuculus neglectus* SCHLEG., the type of Salvadori's genus *Heterococcyx*, appears to be a young example of *C. basalis* (HORSF.)].

**Centropus bengalensis javanensis** (DUMONT).

1 ♂ 1 ♀ Northern Boundary. Wings: ♂ 154; ♀ 149 mm.

**Rhopodytes diardi borneensis** SALVAD.

1 ♂ Punt D, 1172 metres. Wing 125 mm.



**Rhopodytes sumatranus** (RAFFLES)

1 ♂ 1 ♀ Telen River; 1 ♂ 2 ♀ Melawi River.

Wings: ♂ 139, 140: ♀ 142, 142, 142 mm.

**Rhinortha cholorophaea chlorophaea** (RAFFLES).

2 ♂ Lawas River; 3 ♂ 1 ♀ Northern Boundary; 3 ♂, ♀ 3 Telen River;  
3 ♂ 3 ♀ Melawi River.

Wings: ♂ 105, 106, 107, 108, 110, 111, 111, 112, 112, 113, 113. ♀ 108, 108,  
110, 112, 112, 113, 115 mm.

**Phoenicophaus curvirostris borneensis** (BLAS. & NEHR.).

3 ♂ 2 ♀ Northern Boundary; 3 ♂ Telen River; 1 ♀ Punt D, 1172 metres;  
1 ♂ Borneo (VORDERMANN).

Wings: ♂ 150, 161, 162, 163, 164, 170, 171, 172.

♀ 157, 158, 163, 164 mm.

The series from the Boundary is small, wings 150-163; and we find birds from British North Borneo to be rather small also (152-167). The birds from elsewhere range larger, wings 161-172 mm.

**Carpococcyx radiatus radiatus** TEMM.

1 ♂ Lawas River. Wing 252 mm.

## CAPITONIDAE.

**Calorhamphus fuliginosus fuliginosus** (TEMM.)

2 sex inc. "Borneo". Wings: 78 (VORDERMANN), 80 mm.

In the north of the island occurs the form *C. f. tertius* CHASEN and KLOSS (Journ. f. Ornith., 1929, Bd. 2, p. 110. Sandakan) with the red on the under parts not extending toward the abdomen, but confined to the upper breast.

**Chotorhea chrysopogon chrysopsis** (COFFIN).

1 ♂ 1 ♀, Telen River; 1 sex inc. Melawi River; 1 sex inc., Borneo (VORDERMANN).

Wings: ♂ 118; ♀ 119, sex inc. 114, 120 mm.

**Chotorhea mystacophanes mystacophanes** (TEMM.).

2 ♂ 2 ♀, Northern Boundary; 3 ♂ 1 ♀ Telen River.

Wings: ♂ 93, 93, 94, 96, 99. ♀ 91, 92, 99 mm.

**Chotorhea rafflesi** (LESS.) [*Chotorhea versicolor* auct.].

1 ♂ Northern Boundary; 1 ♀ Moeara Antjaloeng; 1 ♂ 1 ♀ Melawi River.

Wings: ♂ 115, 120: ♀ 116, 120 mm.

**Chotorhea monticola** SHARPE.

1 ♂ 1 ♀ Punt D, 1172 metres. Wings: ♂ 103, ♀ 103 mm.



**Mesobucco duvauceli duvauceli** (LESS.).*M. d. borneonensis* (PARROT.).

1 ♂ Northern Boundary; 2 ♂ Marah.

Wings: 73, 75, 76 mm.

Ear-coverts black. Exactly like typical birds.

## PICIDAE.

**Picus puniceus observandus** (HARTERT.).

1 ♀ Northern Boundary; 3 ♂ Telen River.

Wings: ♂ 118, 118, 125; ♀ 115 mm.

This is the race occurring in Sumatra as well.

**Callolophus miniatus dayak** STRESEM.

1 ♂, Marah. Wing 119 mm.

STRESEMANN separated Bornean birds (type locality Landak River, near Pontianak, S. W. Borneo) on account of small size (wings 119-122 mm.) and the examples from Marah agrees. The wing range of one bird from Sampit, S. Borneo, eight from Sarawak and two from Sandakan is 113-124 mm.

**Callolophus miniatus malaccensis** (LATH.).

1 sex inc. "BORNEO". Wing 132 mm.

This example perhaps came from the Lawas River as we have the long-winged *C. m. malaccensis* from the neighbourhood of Mt. Kinabalu. It would seem that over a small area in North Borneo the larger Malayo-Sumatran race occurs.

**Chrysophlegma mentale saba** CHASEN & KLOSS, Journ. f. Ornith., 1929, Bd., 2. p. III. (Sandakan).

3 ♂ 3 ♀ Telen River; 1 ♂ 1 ♀ Punt D, 1172 metres.

Wings: ♂ 125, 127, 129, 130. ♀ 122, 125, 127, 127 mm.

These birds are best placed with the small form described from the neighbourhood of Sandakan which they approach nearest in the colour of the moustachial stripe and in size, though a little larger than the type series.

*C. m. humei* of the Malay Peninsula occurs also in Sumatra and in the western half of Borneo. The winglength of the two forms may be stated as

<i>C. m. saba</i>	♂ 120 — 130.	♀ 119 — 127.
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<i>C. m. humei</i>	♂ 128 — 141.	♀ 125 — 139.
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**Chloropicoides rafflesi borneonensis** (HESSE).

1 ♀ Marah. Wing 128 mm.

**Dryobates moluccensis moluccensis** (GM.).

1 ♀ Northern Boundary; 2 ♂ Moeara Antjaloeng.

Wings: ♂ 68, 72 (worn); ♀ 74 mm.



We cannot separate birds from the Malay Peninsula (selected as the type locality by OBERHOLSER in 1919 under the impression (erroneous) that this bird and *Tripsurus auritis* EYTON, of Malacca are the same) Sumatra, Java and Borneo.

The Telen River examples are practically topotypes of *D. m. tantalus* RILEY (Mahakkam River), but they are inseparable from a Malayan-Javan series. The wings of Bornean birds run quite as large as the others.

***Dryobates hardwicki aurantiiventris* (SALVAD.)**

1 ♂ 1 ♀ Melawi River. Wings: ♂ 77: ♀ 81 mm.

Males are more richly coloured on the underparts than females. STRESE-MANN regards this bird as a race of *canicapillus*. The alliance is correct, but *canicapillus* itself is apparently but a subspecies of *hardwicki*.

***Blythipicus rubiginosus parvus* CHASEN and KLOSS, Journ. f. Ornith., 1929, Bd. 2, p. 112 (Sandakan).**

1 ♂ 1 ♀ Long Petah. Wings: ♂ 115: ♀ 117 mm.

This is the Borneo-Sumatran race which is smaller than the typical form from the Malay Peninsula.

***Meiglyptes tristis micropterus* HESSE.**

1 ♂ 2 ♀ Marah; 2 ♂ 2 ♀ Melawi River.

Wings: ♂ 89, 90, 91: ♀ 87, 89, 92, 92 mm.

Bornean birds are like those of Sumatra.

***Meiglyptes tukki tukki* (LESS.).**

1 ♂ Northern Boundary; 1 ♂ 4 ♀ Telen River.

Wings: ♂ 99, 107: ♀ 96, 101, 103, 108 mm.

A bird from Southwestern Borneo has been named *M. t. percnerpes* by OBERHOLSER (Proc. Wash. Acad. Sci., XIII, 1923, p. 301).

***Micropternus brachyurus badius* (TEMME.).**

1 ♀ Lawas River; 1 ♂ 2 ♀ Marah.

Wings: ♂ 110: ♀ 108, 113, 113 mm.

Bornean birds vary a good deal in colour irrespective of locality, but those from Marah are the dullest and darkest we have seen. (They have the appearance of having been preserved in a formalin solution).

***Hemicercus concretus coccometopus* (REICHENB.).**

1 ♂ Marah; 1 ♀ Melawi River. Wings: ♂ 81 : ♀ 85 mm.

Bornean and Sumatran birds are alike.

***Mulleripicus pulverulentus pulverulentus* (TEMME.).**

1 ♀ Marah. Wing 219 (very worn).

A male from the Baram River has the wing (somewhat worn) 237 mm.

***Sasia abnormis abnormis* (TEMME.).**

5 ♂ 4 ♀, Telen River; 1 ♂ Melawi River.

Wings: ♂ 53 (imm.), 53, 54, 54, 54, 56: ♀ 54, 54, 55, 56 mm.



## EURYLAIMIDAE.

**Calyptomena viridis viridis** RAFFLES.

5 ♂ 2 ♀ Northern Boundary.

Wings: ♂ 93, 94, 95, 99 (imm.), 100 (imm.) : ♀ 97, 99 mm.

Birds from Sumatra and Borneo are alike.

**Calyptomena hosei** SHARPE.

1 ♂ Long Petah. Wing, 120 mm.

**Eurylaimus javanicus brookei** ROBINSON & KLOSS.

1 ♂ 1 ♀ Long Petah. Wings: ♂ 106 : ♀ 104 mm.

**Eurylaimus ochromalus kalamantan** ROBINSON & KLOSS.

3 ♂ 1 ♀ Northern Boundary. 1 ♀ Moeara Wahau, 1 ♂ Melawi River.

Wings: ♂ 81, 81, 81, 85 : ♀ 76, 78 mm.

**Corydon sumatranus brunnescens** HARTERT.

1 ♀ Northern Boundary, 4 ♀ Marah.

Wings: ♂ 126 : ♀ 125, 126, 128, 128 mm.

**Cymborhynchus macrorhynchus macrorhynchus** (GM.).

2 ♂ Northern Boundary; 1 ♂ 2 ♀, 2 sex inc. Telen River; 4 ♂ 1 ♀ Melawi River.

Wings: ♂ 101, 104, 105, 107, 108, 108, 110 : ♀ 102, 105, 105 : sex inc., 107, 108 mm.

Five of the series have a slight irregular trace of white on the tail: in the others the tail is entirely black.

## PITTIDAE.

**Pitta brachyura cyanoptera** TEMM. [*Pitta moluccensis* AUD.].

1 ♀ Borneo. Wing 122 mm.

**Pitta venusta ussheri** SHARPE.

1 ♀ Lawas River; 1 sex inc. Northern Boundary.

Wings: ♀ 87: sex inc. 90 mm.

**Pitta granatina granatina** TEMM.

1 ♀ Long Leang Leng. Wing 92 mm.

**Pitta sordida mulleri** BP.

1 ♀ Lawas River; 2 ♂ 2 ♀ Telen River.

Wings: ♂ 108, 110: ♀ 104 (imm.), 107, 112 mm.

There is often a patch of white feathers on the black foreneck. The thighs are brownish-green to blackish.

**Pitta arcuata** GOULD.

1 ♀ "Borneo".



***Eucichla guajana schwaneri* (Bp.)**

cf. KLOSS, Journ. Malayan Branch, Royal Asiat. Soc., IV, 1926, p. 161.  
1 ♂ Punt D, 1172 metres. Wing 96 mm.

## MUSCICAPIDAE.

***Hemichelidon ferruginea* HODGS.**

1 ♂ Punt D. 1172 metres. Wing 69 mm.

An immature bird with a white-spotted blackish crown and large pale patches on the mantle.

***Hemichelidon sibirica sibirica* (Gm.)**

1 ♂ 1 ♀ Long Petah. Wings: ♂ 79: ♀ 77 (immature: spotted white above).

***Cyornis concreta everetti* SHARPE.**

3 ♂ 1 ♀ Punt D, 1172 metres.

Wings: ♂ 83, 84, 86 (imm.): ♀ 83 mm.

The immature male has the head spotted with bright rufous and has an edge of rufous feathers to the mandible.

***Cyornis caerulea caerulea* (Bp.).**

8 ♂, 2 ♀ Telen River.

Wings: ♂ 73 (imm.), 73, 74, 74, 75 (imm.), 75 (imm.), 75, 78: ♀ 70, 71 mm.

In Western Borneo occurs a slightly different race *C. c. rufifrons* WALLACE, the males more deeply coloured below, the females with more blue on the upper parts.

***Cyornis turcosa turcosa* BRUGGEMANN.**

5 ♂ 3 ♀ Telen River.

Wings: ♂ 76, 77, 77, 78, 78: ♀ 71, 72, 73 mm.

In North and West Borneo is found *C. t. rufatensis* OBERHOLSER.

***Cyornis superba* STRESEM.**

4 ♂ 2 ♀ Telen River.

Wings: ♂ 72, 73, 75, 76: ♀ 69, 71 mm.

The amount of white on the abdomen is variable. In a male from British North Borneo it is hardly present at all; on the other hand a female from Long Temelen, which has an unusually large area of white on the abdomen, has the under tail-coverts white also, and the foreneck unusually pale. Confined to Borneo.

***Oreicola dumetoria mülleri* (TEMME.)**

1 ♂ imm., Long Petah. Wing 61 mm.

Juvenile males closely resemble adult females: this example is beginning to assume its adult plumage. The wing is darker than in females, the fulvous edges turning white: rump and tail black.

***Hypothymis azurea prophata* OBERH.**

2 ♀ Telen River; 2 ♂ 1 ♀ Melawi River.

Wings: ♂ 67, 70; ♀ 67, 67, 71 mm.



**Rhipidura perlata** (S. MULL.)

1 ♂ Long Huet; 1 ♂ Punt D, 1172 metres.

Wings 86, 87 mm.

**Rhipidura javanica longicauda** (WALL.).

1 ♂ Moeara Antjaloeng. Wing 79 mm.

The typical form is confined to Java.

**Terpsiphone paradisi borneensis** (HARTERT).

2 ♀ Northern Boundary; 5 ♂ Telen River; 1 ♂ 1 ♀ Punt D, 1172 metres.

Wings: ♂ 87 (in ♀ plumage), 93, 94, 95, 95: ♀ 87, 88, 89 mm.

The longest tail of the series is 385 mm.

**Drymophila velata caesia** (LESS.).

1 ♂ Northern Boundary; 1 ♂ 1 ♀ Long Huet; 3 ♂ Punt D, 1172 metres.

Wings: ♂ 96, 100, 100, 103, 104: ♀ 94 mm.

The typical form is confirmed to Java.

**Drymophila pyrrhoptera pyrrhoptera** (TEMME.).

2 ♂ 2 ♀ Telen River; 1 ♂ (?) Punt D, 1172 metres.

Wings: ♂ 84, 84, 82 (?): ♀ 79, 80 mm.

**Rhinomyias umbratilis umbratilis** (STRICKL.).

1 sex inc. Lawas River; 4 ♂ 1 ♀ Telen River; 1 ♀ Punt D, 1172 metres.

Wings: ♂ 76, 77, 78, 79: ♀ 74, 76; sex inc. 77 mm.

**Rhinomyias ruficrissa** SHARPE.

1 ♂ subad. 1 ♀ imm. Punt D, 1172 metres.

Wings: ♂ 81: ♀ 77 mm.

The immature female is an undoubted example of *ruficrissa*, but it has the crown darker than in adults and large fulvous spots on the mantle, sides of neck and wing-coverts. The male agrees exactly neither with this species nor with *umbratilis* but, having dark lores, appears to belong to *ruficrissa* though *umbratilis* occurs in the same locality (q.v.). It is paler above than either species, the upper parts having a distinct yellowish tinge.

**Culicicapa ceylonensis ceylonensis** (SWAINS.).

1 ♂ 1 ♀ Telen River; 1 ♂ Punt D, 1172 metres.

Wings: ♂ 61, 61; ♀ 56 mm.

## CAMPEPHAGIDAE.

**Coracina sumatrensis sumatrensis** (S. MÜLL.).

1 ♂ Marah. Wing 147 mm.

**Lalage fimbriata culminata** (A. HAY).

1 ♂ 1 ♀ Moeara Antjaloeng. Wings: ♂ 92: ♀ 87 mm.



## PYCNONOTIDAE.

**Aegithina viridissima viridissima** (BP.).

1 ♂ Lawas River, 4 ♂ 1 ♀ Telen River, 1 ♂ Melawi River.

Wings: ♂ 60, 60, 62, 63, 63, 65: ♀ 62 mm.

**Aegithina tiphia viridis** (BP.).

2 ♂ 1 ♀ Lawas River, 1 ♂ Northern Boundary.

Wings: ♂ 61, 64, 64: ♀ 62 mm.

**Aegithina tiphia damicra** OBERH.

1 ♀ Koetai (CARL BOCK), 1 ♂ 1 ♀ Telen River, 1 ♂ Melawi River.

Wings: ♂ 59, 62: ♀ 58, 59 mm.

By erecting *Ae. t. damicra* for S. W. Borneo and *Ae. t. zophonota* for central East Borneo OBERHOLSER <sup>1)</sup> has, by elimination, left only the northern part of the island as terra typica for *Ae. t. tiphia* (BP.). — a most unlikely locality whence birds would have reached TEMMINCK.

The specimens listed above are practically topotypes of both OBERHOLSER'S races, but they are inseparable from each other. Birds from the southern half of Borneo though not smaller than those from the North-west, whence a large series has a wing-range of 59-64 mm., may however be known as *Ae. t. damicra* (which has place priority over *zophonota*) on account of being duller and greener than northern birds.

**Chloropsis viridis zosterops** VIG.

1 ♂ Lawas River; 1 ♂ Northern Boundary; 2 ♂ 1 ♀; Telen River, 1 ♂ 1 ♀ Melawi River.

Wings: ♂ 100, 102, 102, 103, 105: ♀ 93, 94 mm.

When large series are examined it seems impossible to maintain *viriditectus* HARTERT for Bornean birds.

**Chloropsis cyanopogon cyanopogon** (TEMM.).

1 ♂ Lawas River; 2 ♂ 2 ♀ Telen River; 1 ♂ 1 ♀ Melawi River.

Wings: ♂ 82, 83, 83, 88: ♀ 72, 75, 79 mm.

**Chloropsis cochinchinensis viridinucha** SHARPE.

1 ♀ Melawi River. Wing 80 mm.

**Irena puella criniger** SHARPE.

1 ♂ 1 ♀ Northern Boundary; 2 ♂ 2 ♀ Telen River; 1 ♂ Melawi River.

Wings: ♂ 117, 117, 117, 119: ♀ 115, 116, 116 mm.

**Ixos malaccensis malaccensis** (BLYTH.).

1 sex inc. Lawas River, 3 ♂ Melawi River.

Wings: ♂ 107, 109, 109: sex inc. 108 mm.

<sup>1)</sup> Smithsonian Misc. Collection, 76, No. 6, 1923, pp. 6, 7.



***Iole olivacea charlottae* (FINSCH.).**

2 ♀ Lawas River, 1 ♀ Long Huet, 1 ♂ Melawi River.

Wings: ♂ 87; ♀ 81, 82, 82 mm.

***Euptilosus euptilosus* (JARD. & SELBY).**

1 ♂ 1 ♀ Telen River. Wings: 95, 95 mm.

***Brachypodius atriceps atriceps* (TEMME.).**

2 ♂ 2 ♀ Northern Boundary; 4 ♂ 1 ♀ Long Petah; 2 ♂ Melawi River.

Wings: ♂ 71, 72, 75, 75, 76, 77, 77, 78; ♀ 73, 74, 77 mm.

***Criniger gutturalis gutturalis* (BP.).**

1 ♀ Northern Boundary, 1 ♂ 3 ♀ Telen River; 2 ♂ Melawi River.

Wings: ♂ 105, 107, 110; ♀ 102, 104, 105, 110 mm.

***Criniger gutturalis ruficrissus* SHARPE.**

2 ♂ Punt D, 1172 metres. Wings: 112, 113 mm.

A mountain form of the last.

***Criniger finschi* SALV.**

1 ♂ Melawi River. Wing 88 mm.

***Alophoixus phaeocephalus connectens* CHASEN & KLOSS.**

Journ. f. Ornith., 1929, Bd. 2, p. 114 (Sandakan).

1 ♂ Northern Boundary. Wing 95 mm.

This form, based on Sandakan birds, obviously extends down the East Coast at least as far as the Northern Boundary of Netherlands Borneo.

It is distinguished among the Bornean races by the entire absence of yellow tips to the tail feathers: at most, a slight buffy tinge can be distinguished at the extremities on the lower side only.

From the typical *Alophoixus phaeocephalus* (HARTL.) of Malacca, occurring also in Sumatra, it differs in having the lower foreneck grey instead of white.

***Alophoixus phaeocephalus medius* subsp. nov.**

1 ♀ Marah, 1 ♂ 1 ♀ Long Poatoes, 1 ♀ Long Huet, 2 ♂ 1 ♂ Long Petah,

1 ♂ Punt D, 1172 metres.

Wings: ♂ 94, 99, 102, 100; ♀ 90, 91, 92, 95 mm.

With these birds may be placed an example from Kabayo, near the foot of Mt. Kinabalu.

Intermediate between *A. p. diardi* (FINSCH) from Pontianak, S. W. Borneo, and *A. p. connectens* CHASEN and KLOSS, from Sandakan N. E. Borneo, having much less yellow at the tip of the tail than the former while the latter has no yellow tail-tip at all, at most an indefinite buffy edge being visible on the under surface.

*Type.* Adult male from Long Petah, Telen River, East Borneo. Collected by H. C. SIEBERS, on 24th October, 1925. Collectors Number 228.



A female from the type locality (No. 252) possesses the largest yellow tail-tip of the series, but it falls far short of the large clear yellow tip of *diardi*. A female from Marah (No. 403) shows approach to *connectens*, but its tail is still distinctly yellow-tipped.

*A. p. connectens* probably occupies the eastern half of British North Borneo and extends into the adjacent area of Netherlands Borneo.

*A. p. diardi* probably occurs in the western half of Netherlands Borneo: it extends through Sarawak to the Baram district.

The rest of the island, viz., Western British North Borneo, Brunei, part of the Baram District of Sarawak, and the greater part of Eastern Netherlands Borneo, is doubtless the habitat of *A. p. medius*. For to this somewhat variable race probably belong some of the birds from the Baram District which HOSE has recorded as *phaeocephalus* and *diardi* (Ibis, 1893, p. 390) and SCHWANER's bird from Bandjermasin listed as *phaeocephalus* (the only one so determined in the Leyden Museum) with others from the same area listed as *diardi* <sup>1)</sup>. [*Trichophorus sulphuratus* MÜLL. in Bp., said by BONAPARTE to be from Borneo, is actually based on a bird collected by HORNER in West Sumatra. Vide FINSCH, Notes, Leyden Museum, XXVI p. 107].

***Tricholestes criniger viridis* (BP.).**

2 sex. inc. Lawas River, 1 ♂ 5 ♀ Telen River.

Wings: ♂ 74: ♀ 66, 69, 69, 71, 72: sex inc. 68, 71 mm.

***Trachycomus zeylanicus* (GM.).**

2 ♂ 1 ♀ Northern Boundary, 1 ♂ Moeara Wahau, 1 ♂ 2 ♀ Melawi River.

Wings: ♂ 111, 119, 119, 121: ♀ 115, 117, 118 mm.

***Pycnonotus goiaver gourdini* JACQ. & PUCH.).**

1 ♀ Northern Boundary. Wing 82 mm.

***Pycnonotus plumosus insularis* CHASEN & KLOSS.**

Journ. f. Ornith. 1929, Bd. 2, p. 115 (Banguay Id.).

1 ♀ Lawas River, 2 ♂ 1 ♀ Moeara Wahau, 1 ♂ Melawi River.

Wings: ♂ 81, 82, 84: ♀ 84, 85 mm.

***Pycnonotus brunneus brunneus* MOORE.**

1 ♂ 3 ♀ Telen River.

Wings: ♂ 80: ♀ 73, 78, 80 mm. One of the females is very small, but on colour belongs to this species.

***Pycnonotus simplex perplexus* CHASEN & KLOSS.**

Journ. f. Ornith., 1929, Bd. 2, p. 116 (Balambangan Id.).

1 ♂ Lawas River, 1 ♀ Marah. Wings: 80, 80 mm.

On the presumption that these birds have red irides, like all other Bornean examples accompanied by data that we possess, we place them under the above name.

<sup>1)</sup> vide FINSCH, Notes Leyden Mus., XXVI, 1905, pp. 107, 108.



***Pycnonotus erythrophthalmos salvadori* SHARPE.**

4 ♂ 2 ♀ Telen River, 1 ♂, 1 sex inc. Melawi River.

Wings ♂ 74, 74, 75, 75, 75: ♀ 70, 75: sex inc. 76 mm.

***Pycnonotus cyaniventris paroticalis* (SHARPE).**

1 ♂ Punt D, 1172 metres. Wing 76 mm.

***Otocompsa flaviventris montis* SHARPE.**

1 ♀ Punt D, 1172 metres. Wing 81 mm.

## TIMALIIDAE.

***Pomatorhinus montanus borneensis* (CAB.).**

1 ♂ 1 ♀ Long Petah, 1 ♂ 1 ♀ Punt D, 1172 metres. 1 sex inc. Borneo (VORDERMANN).

Wings: ♂ 85, 87, 90: ♀ 84, 86 mm.

***Malacocincla abbotti büttikoferi* FINSCH.**

1 ♂ Moeara Wahau. Wing 75 mm.

***Malacocincla sepiaria rufiventris* (SALVAD.).**

3 ♂ Telen River, 1 ♀ Melawi River.

Wings: ♂ 73, 75, 77: ♀ 73 mm.

***Erythrocichla bicolor* (LESS.).**

1 ♂ Long Huet. Wing 87 mm.

***Pellorneum capistratum capistratoides* (TEMM.).**

1 sex inc. Lawas River, 1 ♂ 5 ♀ 2 ♀ imm., Telen River.

Wing: ♂ 70: ♀ 65, 66, 67, 68, 70 mm.

In the north of the island occurs *P. c. morrelli* CHASEN and KLOSS, (Journ. f. Ornith. 1929, Bd. 2, p. 118. Kudat) a paler bird with the ear-coverts greyer.

***Aethostoma rostrata macroptera* (SALVAD.).**

[syn. *witmeri* SHARPE, *umbratile* auct.].

2 ♂ Telen River. Wings: 68, 70 mm.

***Aethostoma pyrrhogenys canicapillus* (SHARPE).**

2 ♀ Punt D, 1172 metres. Wings 67, 68 mm.

These two specimens collected in 1925 and two from Mr. DULIT, N. Sarawak, collected in 1919 are darker and more rufous above than three recently secured topotypes. If all had been collected at the same date I should have no hesitation in separating the former birds, but I think the difference in colour is due to postmortem changes in the older specimens to which birds of their colour are very liable.



**Malacopteron magnum magnum** EYTON.

4 ♂ 1 ♀ Telen River, 1 sex inc. Borneo (VORDERMANN).

Wings: ♂ 90, 91, 91, 94: ♀ 86: sex inc. 87 mm.

In the North of the island occurs a race with much less black on the occiput, *M. m. saba* CHASEN and KLOSS, Bull. Raffles, Mus, No. 4 1930, p. 75. North Borneo.

**Malacopteron cinereum cinereum** EYTON.

2 ♂ Long Peth. Wings: 78, 80 mm.

**Malacopteron magnirostis kalulongae** (SHARPE).

1 ♀ Long Huet, 1 ♂ Punt D, 1172 metres.

Wings: ♂ 78: ♀ 75 mm.

**Malacopteron affine affine** (BLYTH).

1 sex inc. Lawas River, 11 ♂ 9 ♀ Telen River, 1 ♂ Melawi River.

Wings: ♂ 74, 75, 76, 77, 77, 77, 77, 77, 78, 79, 79; ♀ 67, 70, 70, 72, 72, 72, 74, 75 mm.

The small female has the secondaries rufous and the head paler than the others.

**Anuropsis malaccensis saturatus** ROB. & KLOSS.

2 ♂ Melawi River. Wings: 68, 69 mm.

This is the form inhabiting the west of Borneo, at least from the Kapuas to the Baram River: it occurs, apparently, on the upper Mahakkam River also (vide BÜTTIKOFER, Notes Leyden Museum XXI, p. 241). It is richly coloured below and has the crown earthy brown, or concolorous with the mantle, and the tail scarcely tinged with rufous.

**Anuropsis malaccensis poliogenis** STRICKLAND.

4 ♂ 2 ♀ Telen River, 1 ♀ Punt D, 1172 metres.

Wings: ♂ 70, 71, 73, 75: ♀ 64, 68, 70 mm.

Two specimens from the Karau River, S. E. Borneo <sup>1)</sup>, and two from the Trusan River, Brunei, were stated by BÜTTIKOFER (l.c.s.) to differ from birds of the upper Kapuas River (which are *A. m. saturatus*). He further considered that the South-eastern birds were more richly tinged with orange-rufous on the lower side (as in *saturatus*) than were the Brunei specimens.

The former represent *poliogenis*, the latter *A. m. sordidus* CHASEN & KLOSS. (Journ. f. Ornith., 1929, Bd 2, p. 119. Sandakan).

The seven birds listed here from Central East Borneo are a little more richly coloured below than eight from North Borneo, but they can be matched by eight others from the same area (and it is possible that BÜTTIKOFER's two specimens from each locality did not represent the individual variation). They agree with northern birds in having a rufous-tinged crown

<sup>1)</sup> A left bank tributary of the Barito, and probably the type locality of *Brachypteryx poliogenis* Strickl.



and more rufous tail feathers than *saturatus* as well as in being less richly coloured below. They should stand as *A. m. poliogenis* to the synonymy of which may, for the present, be relegated *A. m. sordidus* though, later, differences may be found to exist between birds from the north and from the southern type locality.

***Turdinulus epilepidotus exsul* SHARPE.**

1 ♂ 1 ♀ Punt D, 1172 metres. Wings: 57, 57 mm.

***Alcippe cinerea cinerea* BLYTH.**

1 sex inc., Lawas River, 4 ♂ 3 ♀ Telen River.

Wings: ♂ 69, 70, 70, 71: ♀ 64, 67, 67: sex inc. 68 mm.

The Lawas River example, an old faded specimen, agrees exactly with the description of *A. eriphaea* OBERHOLSER, from Liang Koebang, Central Borneo (Smithsonian Misc. Collns. 74, No. 2, 1922, p. 2), which was based on a skin twenty-eight years old.

Freshly collected birds from the Malay Peninsula, Natuna Islands, Borneo and Sumatra are all alike. We have not seen *A. hypocneca* OBERH., from the Batu Islands.

***Stachyris poliocephala poliocephala* (TEMME.).**

*Stachyris poliocephala diluta* ROBINSON & KLOSS.

1 ♂ Northern Boundary, 2 ♂ 1 ♀ Long Petah, 2 ♂ Melawi River.

Wings: ♂ 68, 69, 70, 71, 73: ♀ 69 mm.

***Stachyris nigricollis nigricollis* (TEMME.).**

1 ♂ Long Huet: 1 ♂ 1 ♀ Melawi River.

Wings: ♂ 73, 75: ♀ 70 mm.

***Stachyris maculata maculata* (TEMME.).**

1 ♂ 1 ♀ Telen River. Wings: 88 and 81 mm.

***Cyanoderma erythroptera bicolor* (BLYTH.).**

2 sex inc., Lawas River, 5 ♂ 7 ♀ Telen River, 1 ♂ Melawi River.

Wings: ♂ 57, 60, 60, 61, 61, 62: ♀ 55, 56, 67, 67, 58, 60: sex inc. 60, 61 mm.

This name (type locality, Labuan) may be used for all Bornean birds except those of the south (*C. e. rufa* CHASEN & KLOSS. Sampit). It is true that individuals from the extreme north are paler above than those from the equator, but birds from Labuan and its vicinity practically illustrate all the variation.

***Mixornis gularis borneensis* BP.**

2 ♂ 1 sex inc. Lawas River, 5 ♂ 1 ♀ Telen River.

Wings: ♂ 60, 64, 65, 65, 66, 67, 67: ♀ 61: sex inc. 63 mm.

This race occurs southwards of Brunei: it is replaced in British North Borneo by *M. g. montana* SHARPE.



**Macronus ptilosus reclusus** HARTERT.

1 ♂ Northern Boundary, 5 ♂ 1 ♀ Telen River, 2 ♂ 2 ♀ 1 sex inc. Melawi River.

Wings: ♂ 70, 71, 73, 74, 74, 75, 75, 77: ♀ 70, 70, 71: sex inc. 75 mm.

**Staphidia castaneiceps everetti** SHARPE.

1 ♂ Punt D, 1172 metres; 1 ♀ Melawi River.

Wings: 63 and 60 mm.

## TURDIDAE.

**Geocichla interpres interpres** (KUHLMANN in TEMM.).

2 ♂ 1 ♀ Telen River. Wings: ♂ 101, 103: ♀ 100 mm.

**Enicurus ruficapillus** TEMM.

1 ♂ Northern Boundary. Wing 90 mm.

**Enicurus leschenaulti frontalis** BLYTH.

1 ♂ 2 ♀ Long Petah.

Wings: ♂ 95: ♀ 89, 97 mm.

Tails ♂ 102: ♀ imp., 86 mm.

I regard *frontalis* of the Malay Peninsula, Sumatra and Borneo as a small form of *leschenaulti* with a relatively shorter tail. As in the Javan bird the white area of the head is elongated and rather pointed posteriorly. SHARPE's genus *Hydrocichla* seems unnecessary.

**Enicurus leschenaulti borneensis** SHARPE.

1 ♀ imm., Punt D, 1172 metres. Wing 96, tail 115 mm.

No white on forehead; head, neck, breast and mantle dark brown with a few black feathers.

A mountain form: somewhat larger than *frontalis* with a longer tail. It differs from *leschenaulti* and *frontalis* and agrees with the northern forms of the species (*indicus* and *sinensis*) in having the white area of the forehead rounded posteriorly.

Five examples measure: — Wings 96-102, tails 115-130 mm. Fifteen specimens of *frontalis* from its various habitats measure: — Wings 85-97, tails 82-102 mm.

**Copsychus saularis pluto** Bp.

2 ♂ ad 1 ♀ juv. Telen River.

Wings: ad. 107, 109 mm.

**Copsychus saularis pluto > niger** WARDL. RAMS.

1 ♀ Northern Boundary. Wing 102 mm.



**Copsychus saularis niger** > **problematicus** SHARPE.

1 ♀ Lawas River. Wing. 102 mm.

**Copsychus saularis problematicus** SHARPE.

1 ♂ Melawi River. Wing 106 mm.

For a treatment of the Malaysian forms of *Copsychus* see CHASEN and KLOSS in Bull. RAFFLES Museum, No. 4, pp. 84-90. 1930.

**Kittacincla stricklandi stricklandi** (MOLL. & DILLW.).

1 ♂ imm. 2 ♀ Northern Boundary.

Wings: ♂ 100: ♀ 90, 90 mm.

The male (immature) has large rufous spots on the wing-coverts.

**Kittacincla malabarica suavis** SCLATER.

*Kittacincla malabarica zaphonota* OBERHOLSER, Smithsonian Misc. Collns, 76, No. 6, 1923, p. 6: Central Borneo to S. W. Borneo.

♂ Lawas River, 1 ♂ Northern Boundary, 3 ♀ Telen River, 1 ♂ Melawi River.

Wings: ♂ 101, 102, 103: ♀ 87, 88, 88 mm.

The Melawi River example probably represents *zaphonotha*, but it does not differ from the others.

**Trichixos pyrropyga** LESS.

1 ♂ Lawas River, 1 ♂ 3 ♀ Telen River.

Wings: ♂ 103, 108: ♀ 93 (juv.), 97, 97 mm.

## SYLVIIDAE.

**Orthotomus atrogularis atrogularis** TEMM.

1 ♂ Long Petah. Wing 46 mm.

At Sandakan occurs *O. a. humphreysi* CHASEN & KLOSS (Journ. f. Ornith., 1929, Bd 2, p. 120) with the underparts pale lemon yellow.

**Orthotomus ruficeps sericeus** TEMM.

1 ♂ 1 ♀ Telen River. Wings 52 and 50 mm.

**Orthotomus sepium borneoensis** SALVAD.

1 ♂ 2 ♀ Telen River. Wings: ♂ 47: ♀ 44, 46 mm.

**Phylloscopus borealis borealis** (BLAS.).

1 ♂ 1 ♀ Long Petah, 1 ♂ 1 ♀ Punt D, 1172 metres, 3 sex inc. Melawi River.

Wings: ♂ 65, 67: ♀ 62, 63: sex inc. 63, 63, 65.

One of the latter possesses the long first primary attributed to *P. b. xanthodryas* SWINH.

**Prinia flaviventris superciliaris** SALVAD.

2 ♂ Telen River. Wings: 47, 48 mm.



## LANIIDAE.

**Pityriasis gymnocephala** TEMM.

1 ♀ Koetai (VORDERMAN). Wing 140 mm.

**Hemipus hirundinaceus** (TEMM.).

1 ♀ Lawas River. Wing 62 mm.

**Platylophus galericulatus lemprieri** NICHOLSON.

2 ♂ 2 ♀ Northern Boundary. Wings: ♂ 120, 123; ♀ 122, 134 mm.

None of these are quite so pale as topotypes of the race which occurs at Sandakan.

**Platylophus galericulatus coronatus** (RAFFLES).

2 ♂ Telen River. Wings 131, 134 mm.

One of these shows approach to the paler *lemprieri*, as do some birds from Sarawak.

**Lanius tigrinus** DRAP.

1 ♂ 1 ♀ Melawi River. Wings: 85 and 79 mm.

**Pachycephala hypoxantha** SHARPE.

1 ♂ 1 ♀ Punt D, 1172 metres. Wings 84 and 86 mm.

A mountain bird.

## SITTIDAE.

**Sitta frontalis corallipes** SHARPE.

1 ♂ Long Huet. Wing 75 mm.

## CORVIDAE.

**Platysmurus leucopterus aterrimus** (TEMM.).

1 ♂ 1 ♀ Northern Boundary. Wings: 196 and 177 mm.

## DICRURIDAE.

**Dissemurus paradiseus brachyphorus** (BP.).

2 ♂ 2 ♀ Northern Boundary, 2 ♂ 4 ♀ Marah, 1 ♂ 2 ♀ 1 sex inc. Melawi River.

Wings: ♂ 136, 137, 139, 141, 145; ♀ 129, 130, 130, 133, 133, 134, 137, 139 mm.

## ORIOLIDAE.

**Oriolus xanthonotus xanthonotus** HORSF.

1 ♀ Lawas River. Wing 97 mm.

This race occurs in Sarawak and probably over all western Borneo.

**Oriolus xanthonotus consobrinus** WARDL. RAMS.

1 ♂ Northern Boundary, 4 ♂ 2 ♀ Telen River.

Wings: ♂ 110, 112, 114, 114, 115; ♀ 107, 108 mm.

This race is found in British North Borneo and perhaps extends throughout the eastern parts of the island.



## STURNIDAE.

**Gracula javana javana** (Cuv.).

3 ♀ Northern Boundary, 1 ♀ Melawi River.

Wings: 173, 173, 175, 177 mm.

**Aplonis panayensis strigatus** (HORSF.).

3 ♂ Northern Boundary, 1 ♂ Moeara Wahau.

Wings 95 (M. Wahau) 96, 98, 99 mm.

These are the shorter-winged birds which also occur in Sarawak, not the larger race with a heavier bill [*A. p. heterochlorus* (OBERH.)] occurring on the islands of the South China Sea and on Balambangan and Banguay Islands, though two of the examples from the Boundary show an approach to it in this feature and may be indicated as *A. p. strigatus* > *heterochlorus*.

OBERHOLSER has described from Eastern Borneo (type locality Kota Bangoen, on the Mahakkam River, about 50 miles N. W. of Samarinda) a subspecies of glossy starling under the name of *eustathis* (Journ. Wash. Acad. Sci., 16, 1926, p. 516). The wing of the type male is given as 93.5 mm., which is well within the range of the Javanese race, *A. p. strigatus*. It is said to differ from Sumatran birds (which are themselves of the Javanese race) in having the green of the plumage more oily or yellowish. I can see no colour or any other differences except the slightly more robust bill in most of the more northern specimens (Boundary, British North Borneo and Labuan) between the Bornean birds and a Javanese series. These northern birds are unstable intermediates — the bills varying considerably — and do not deserve a name.

Several races of Glossy Starling have been proposed from islands lying off Borneo which itself (except in the extreme north as stated above) is occupied by *A. p. strigatus* (HORSF.). The wings of Javanese birds range from 89 mm (fide STRESEMANN, Nov. Zool. XX, 1913, p. 376) to 102 mm (in my collection) and the race further occupies Sumatra (syn. *insidiator* RAFFLES), Banka, the whole of the Malay Peninsula (syn. *halictypus* OBERH.) and Borneo, except as above.

The wings of the typical Philippine bird, *A. p. panayensis* (SCOP.), measure from 95 to 111 mm. and the race differs in colour from *strigatus* (fide STRESEMANN l.c.s.). As all the Malaysian birds I have seen are alike in colour, it may be taken that all differ from *panayensis* in this respect, whatever their size.

The first of the more recent forms to be proposed is *heterochlorus* (OBERHOLSER, 1917) from the Anamba Islands between the Malay Peninsula and Borneo, described (inter alia) as larger than *strigatus* and of different colour from *panayensis*: the wings of two males were given as 108 and 112 mm. With it OBERHOLSER later (1919) associated birds of the Tambelan Islands, also in the Southern China Sea (wings of a male and female 100.5 and 103.5 mm.). Our series of topotypes measures: — wings ♂ 108, 109; ♀



104, 105, 106, 110 mm. With this race can probably be placed *richmondi* (OBERHOLSER, 1919) from the islet Taya, between Singkep and Banka Islands, also in the Southern China Sea: wings of two males 107 and 108 mm.

We consider to be *heterochlorus* birds from the islands of Aor and Tioman, near the south-eastern coast of the Malay Peninsula: from the Natuna Islands, northeast of the Anamba Group, from the Mantanani Islets, west coast of British North Borneo and from the islands of Balambangan and Banguey off the north coast of Borneo.

As will be seen from the measurements given below *heterochlorus* is larger than *strigatus*: it has also a larger bill: characters developed on apparently all the off-shore small and medium-sized islands of Malaysia. I can find no colour differences.

Aor,	Wings ♂ 103, 105, 105, 105, 106, 107, 110, 112: ♀ 102, 103, 105, 105, 105, 106 mm.
Taya,	„ ♂ 107, 108 mm.
Anambas,	„ ♂ 108, 108, 109, 112: ♀ 104, 105, 106, 110 mm.
Tambelans,	„ ♀ 103.5 mm.
Natunas,	„ ♂ 105, 105, 108, 108: ♀ 102, 102, 102, 104, 104, 104, 105, 105, 106, 106 mm.
Mantanani,	„ ♂ 108 mm.
Balambangan & Banguey	} „ ♂ 102, 105, 106, 108, 109: ♀ 103, 104 mm.

Range ♂ 102-112: ♀ 102-110: both sexes 102-112 mm., i.e., larger than *strigatus*: within the range of *panayensis* but averaging larger and (fide authors) differently coloured. Bill probably heavier.

For birds from islands off the East coast of Borneo two forms have been proposed: *alipodis* (OBERHOLSER, 1926) from Pulo "Pandigang" (wing of the type male 111 mm) and *suggrandis* BANGS and PETERS (1927) from the islands of Maratua and Derawan (lat. 2° 10'-20' N), wings ♂ 111, 113, 113, 114: ♀ 107, 109, 111, 115 mm. A male paratype (wing 111 mm) is indistinguishable from Anambas birds, but the measurements of the series of *suggrandis* indicates that the eastern island birds average larger: BANGS and PETERS apparently overlooked *alipodis* when describing the Maratua bird: it is possible that that name will have to be used for all East Bornean islands birds and that *suggrandis* is a pure synonym of it. The name "Pandigang" is unknown: and I am informed that it is a misprint for "Pandjang". The type of *alipodis* was collected by Dr. H. C. RAVEN about the time of his visit to Maratua Island from which Pulo Pandjang lies about twenty-five miles north east. Derawan is about five miles south of Pandjang.

#### PLOCEIDAE.

##### *Munia atricapilla jagori* MARTENS.

1 ♂ Marah. Wing 51 mm.

Agrees with North Bornean examples.



**Munia fuscans** (CASS.).

1 ♀ Northern Boundary, 3 ♂ 1 ♀ Telen River, 1 ♂ 1 ♀ Upper Mahakkam River (VORDERMANN).

Wings: ♂ 49, 50, 50, 51: ♀ 49, 50, 50 mm.

**Erythrura prasina coelica** BAKER.

3 ♂ Northern Boundary. Wings 56, 58, 59 mm.

These birds have the red of the lower parts more intense and extending farther posteriorly than in the typical form, but none differ from it in colour above: and only one has the more extensive blue area on the breast attributed to Bornean birds (Bull. B.O.C., XLV, 1925, p. 84).

## MOTACILLIDAE.

**Motacilla cinerea caspica** (S. G. GM.).

1 ♀ Long Petah. Wing 79 mm.

**Motacilla flava simillima** HART.

1 ♀ Long Petah. Wing 79 mm.

## NECTARINIIDAE.

**Aethopyga temmincki** (S. MULL.).

2 ♂ Punt D, 1172 metres. Wings: 55, 57 mm.

**Aethopyga siparaja siparaja** (RAFFLES).

2 ♂ Telen River, 1 ♂ 1 ♀ Melawi River.

Wings: ♂ 49, 50, 50: ♀ 47 mm.

**Leptocoma jugularis ornata** LESS.

1 ♂ 1 ♀ Lawas River. Wings 51 and 48 mm.

Birds from Eastern Borneo have been named *heliomanis* by OBERHOLSER (Journ. Wash. Acad. Sci., XIII, 1923, p. 231).

**Anthreptes macularia hypogrammica** (S. MÜLL.).

*Anthreptes hypogrammica intensior* HARTERT.

1 ♂ Lawas River. 4 ♂ 2 ♀ Telen River.

Wings: ♂ 65, 66, 66, 66, 67: ♀ 62, 63 mm.

Bornean birds are like those of Sumatra; both are yellower below than Malayan birds.

**Anthreptes simplex** (S. MÜLL.).

1 ♂ Lawas River, 3 ♂ 2 ♀ Telen River, 1 ♀ Melawi River.

Wings: ♂ 58, 64, 64, 66: ♀ 54, 56, 58 mm.

A bird from "Central Borneo" collected by NIEUWENHUIS has been named *simplicior* by OBERHOLSER (t.c.s., p. 229).



***Anthreptes malaccensis malaccensis* (SCOP.).**

4 ♂ Telen River. Wings: 64, 65, 65, 67 mm.

***Anthreptes malaccensis bornensis* RILEY.**

1 ♂ 1 ♀ Lawas River. Wings 66 and 59 mm.

The birds of this species occurring in North Borneo have been separated on account of their richer colouring.

***Arachnothera longirostra büttikoferi* VAN OORT.**

1 ♂ Lawas River, 5 ♂ 3 ♀ Telen River, 1 ♂ Punt D, 1172 metres, 1 ♂ Melawi River.

Wings: ♂ 68, 68, 68, 68, 69, 69, 70: ♀ 61, 61, 63 mm.

***Arachnothera affinis modesta* (EYTON).**

1 ♀ Long Leang Leng, 1 ♂ Melawi River.

Wings: 81, 81 mm.

***Arachnothera chrysogenys* TEMM.**

1 ♂ Northern Boundary, 1 ♂ Long Petah.

Wings: 82, 85 mm.

Malayan, Sumatra and Bornean birds do not differ from Javanese topotypes except for possible small differences in the length of the bills which have very doubtful value.

***Arachnothera crassirostris* (REICHENB.).**

1 ♂ Long Petah. Wing 86 mm.

**DICAEIDAE.*****Dicaeum cruentatum nigrimentum* SALVAD.**

4 ♂, 1 ♀ Lawas River. Wings: ♂ 47 (imm.), 47 (imm.) 49, 50: ♀ 45 mm.

We think Bornean birds should stand as above owing to their tendency to develop a black throat or foreneck in males, though some are indistinguishable from the typical form.

***Dicaeum trigonostigma dayakana* CHASEN & KLOSS.**

Journ. f. Ornith., 1929, Bd 2, p. 121 (Sandakan).

1 ♂ Marah, 1 ♂ 1 ♀ Melawi River.

Wings: ♂ 47, 48: ♀ 46 mm.

***Dicaeum concolor borneanum* LONN.**

*Dicaeum minullum borneanum* LONNBERG, Sarawak Museum Journal, III, 1925, p. 1, North Sarawak.

1 ♂ Marah, 1 ♀ Telen River.

Wings 45 and 42 mm.



This race, which inhabits Malaysia, differs from *D. c. olivaceum* WALDEN, in being less creamy below: the foreneck, in particular, is more greyish.

***Prionochilus xanthopygius xanthopygius* SALVAD.**

1 ♂ Lawas River, 6 ♂ 5 ♀ Telen River, 1 ♀ Melawi River.

Wings ♂ 52, 53, 53, 54, 55, 55, 56: ♀ 48, 49, 50, 50, 51, 52 mm.

***Prionochilus maculatus maculatus* (TEMM.).**

1 ♂ Long Petah.

Wing 54 mm.



## EINE VOGELSAMMLUNG VOM VULKAN PAPANDAJAN (WEST-JAVA)

von

ERWIN STRESEMANN

(Zool. Museum, Berlin).

Das Berliner Zoologische Museum empfing unlängst von Herrn L. BIESEN-BACH eine grössere Anzahl von Vogelbälgen, welche am G. Papandajan, von 1500 m an bis empor zum Gipfel (2600 m) gesammelt worden waren. Sie gehören 111 Arten an. Die Vogelfauna des isolierten Bergkegels ist in dieser Sammlung noch durchaus nicht vollständig vertreten; ich halte es aber dennoch für nützlich, im folgenden eine Liste der erbeuteten Arten zu veröffentlichen, da sie eine Anzahl nicht unwichtiger Schlussfolgerungen zulässt.

Die Gebirgsvögel sind bekanntlich auf Java keineswegs gleichmässig über alle höheren Vulkane verbreitet. Arten, die auf dem einen Berg häufig sind, fehlen dem anderen durchaus, ohne dass wir bisher den Grund wissen, der vielleicht nicht auf oekologischem, sondern auf verbreitungsgeschichtlichem Gebiet gesucht werden muss.

Es fällt auf, dass in der Liste der Papandajan-Vögel nicht erscheinen:

*Arborophila javanica*

*Irena puella*

*Psaltia exilis*

*Zosterops "palpebrosa"* (richtiger: *Zosterops chlorates*).

Andererseits scheinen auf dem G. Papandajan die folgenden Arten häufig vorzukommen, die auf dem G. Tjiremai meines Wissens bisher noch nicht gesammelt worden sind:

*Pteruthius aenobarbus*

*Chlorura hyperythra*

Die Rassenbildung hat auf dem G. Papandajan bereits eingesetzt, was als Beweis für ein nicht unbeträchtliches Alter seines Besiedlungsbeginns angesehen werden kann. Wir kennen von dort bisher die folgenden Rassen, die von anderen Bergen Javas nicht bekannt sind:

*Turdus javanicus biesenbachi* STRES.

*Cyanoderma melanothorax albigula* STRES.

*Brachypteryx montana* subsp.

Weiterhin zeigt die Vogelliste, dass eine Besiedlung des Vulkans von mehr als einer Seite her erfolgte, denn in einem Falle stimmt die Papandajanrasse überein mit der Rasse des G. Gedeh, aber nicht mit der des G. Tjiremai; in einem anderen Falle verhält es sich umgekehrt.



	Gedeh	Papandajan	Tjiremai
<i>Pycnonotus bimaculatus</i>	barat	barat	bimaculatus
<i>Oreosterops javanica</i>	frontalis	javanica	javanica

Die Zahl solcher Beispiele wird sich vielleicht bei zunehmender Erforschung der Rassenbildung javanischer Vögel noch vermehren lassen.

Ich lasse nunmehr die Liste folgen. Soweit nicht anders vermerkt, sind sämtliche darin aufgeführten Vögel in einer Höhe von etwa 1500 m gesammelt worden. Die Nummern entsprechen denen der "Systematischen Übersicht der bisher von Java nachgewiesenen Vögel" von M. BARTELS jun. und E. STRESE-MANN (TREUBIA XI, 1, 1929).

9. *Amaurornis phoenicura javanica* (HORSF.).  
Flügel ♂ 149-155 mm.
19. *Gallus gallus bankiva* TEMM.
22. *Turnix susculator susculator* (GM.).
25. *Sphenurus oxyurus* (TEMM.).  
Flügel ♂ 155-167 mm.
26. *Sphenurus sphenurus korthalsi* (BP.).  
aus 2600 m Höhe.
31. *Ptilinopus porphyreus* (TEMM.).
- 37a. *Ducula lacernulata lacernulata* (TEMM.).  
Flügel 201-210 mm.
39. *Macropygia unchall unchall* (WAGL.).
40. *Macropygia phasianella emiliana* BP.
41. *Macropygia ruficeps ruficeps* (TEMM.).
42. *Streptopelia chinensis trigina* (TEMM.).
45. *Chalcophaps indica indica* (L.).
92. *Capella stenura* (BP.).  
24. August 1928.
113. *Ixobrychus cinnamomeus* (GM.).
135. *Accipiter trivirgatus trivirgatus* (TEMM.).
- 137a. *Accipiter virgatus virgatus* (TEMM.).
154. *Falco moluccensis occidentalis* MEYER & WIGL.
164. *Glaucidium castanopterum castanopterum* <sup>1)</sup> (HORSF.)
169. *Conurus alexandri alexandri* (L.).
170. *Loriculus vernalis pusillus* SCHLEG.
- 171a. *Eurystomus orientalis orientalis* (L.).
175. *Alcedo meninting meninting* HORSF.
179. *Halcyon smyrnensis cyanoventris* (VIEILL.).

<sup>1)</sup> In der „Systematischen Übersicht“ (1929) versehentlich als *Glaucidium euculoides castanopterum* bezeichnet. (*euculoides* datiert von 1830, *castanopterum* von 1821!).



181. *Halcyon chloris cyanescens* (OBERH.).  
Flügel ♂ 103-112 mm.
186. *Melittophagus erythrocephalus leschenaulti* (VIEILL.).
- 216.? *Cuculus optatus kelungensis* SWINH.  
"♂" (wohl ♀!) juv., Kleingefieder bereits vermausert. Grossgefieder in Mauser aus Jugendkleid ins Alterskleid begriffen. Leider fehlt die vordere Schnabelhälfte. Flügel (Jugendflügel) 168 mm, also viel zu klein für *C. optatus optatus* (GOULD). Merkwürdig das Datum: 3. August 1928.
217. *Cuculus poliocephalus lepidus* S. MÜLL.  
Flügel ♂ ad. 148-157, ♀ ad. 147 mm.
219. *Cacomantis variolosus sepulcralis* (S. MÜLL.).  
Flügel ♂ 113-117, ♀ 112-115 mm.
228. *Zanclostomus javanicus javanicus* (HORSF.).
- 229a. *Phoenicophaes curvirostris curvirostris* (SHAW & NODD.).
230. *Chotorhea chrysopogon corvina* (TEMM.).  
Flügel 123-130 mm.
232. *Cyanops armillaris armillaris* (TEMM.).  
Flügel ad. 91-97 mm. — Nach der Färbung der Kopfplatte lässt sich *C. a. baliensis* RENSCH schwerlich unterscheiden, aber der Schnabel scheint bei *baliensis* im Mittel ein wenig länger zu sein.
235. *Xantholaema haemacephala rosea* (DUM.).
237. *Picus puniceus puniceus* HORSF.  
Am 15. Juni im Jugendkleid.
239. *Chrysophlegma mentale mentale* (TEMM.).  
Flügel ♀ 145-152 mm.
240. *Dryobates analis analis* (BP).  
Flügel ♂ ♀ 93-98 mm.
245. *Chrysocolaptes validus validus* (TEMM.).  
Am 19. April im Jugendkleid.
255. *Hirundo rustica gutturalis* SCOP.  
17.-26. April.
256. *Hirundo tahitica javanica* SPARRM.
261. *Alseonax latirostris* (RAFFL.).  
♂ 23. Mai 1929.
267. *Dendrobiastes hyperythra vulcani* ROB.  
Flügel ♂ 60-61, ♀ 55-58 mm.
268. *Poliomyas mugimaki* (TEMM.).  
Erlegungsdaten: 12. u. 19. April; 6., 17. u. 23. Mai, 2. u. 24. Juni (!); 3. Juli (!).
269. *Muscicapula melanoleuca hasselti* ROB. & KLOSS.  
Flügel ♂ 55-58 mm.
272. *Stoparola indigo indigo* (HORSF.).



273. *Rhipidura phoenicura* S. MÜLL.  
Flügel 70-74 mm.
275. *Rhipidura euryura* S. MÜLL.  
Flügel 81, 82 mm.
279. *Culicicapa ceylonensis ceylonensis* (SWAINS.).  
Flügel 54-63 mm.
282. *Seicercus grammiceps grammiceps* (STRICKL.).  
Flügel 51-52 mm.
283. *Coracina larvata larvata* (S. MÜLL.).
284. *Coracina javanensis javanensis* (HORSF.).
286. *Lalage nigra nigra* (FORST.).
288. *Pericrocotus miniatus* (TEMME.).  
Flügel ♂ 81-84 mm.
292. *Chloropsis cochinchinensis nigricollis* (VIEILL.).
293. *Ixos virescens* TEMME.
- 297a. *Pycnonotus bimaculatus barat* ROB. & KLOSS.  
Flügel 84-91 mm. Der G. Tjiremai wird von der ost-javanischen Rasse *P. b. bimaculatus* (HORSF.) bewohnt.
301. *Pycnonotus aurigaster aurigaster* (VIEILL.).  
Flügel 92-98 mm.
- 305a. *Pomatorhinus montanus montanus* HORSF.  
Flügel 84-92 mm.
306. *Garrulax rufifrons rufifrons* LESS.  
Flügel 118-132 mm.
307. *Malacocincla sepiaria sepiaria* (HORSF.).  
Flügel 66, 69.
310. *Turdinulus epilepidotus epilepidotus* (TEMME.).  
Flügel 56-61 mm.
314. *Alcippe poioicephala pyrrhoptera* (BP).  
Flügel 58-67 mm.
318. *Cyanoderma melanothorax albigula* STRESEM. <sup>1)</sup>.
321. *Brachypteryx montana subsp. nova?*  
*Brachypteryx montana* HORSF. wurde nach Exemplaren vom G. Prahū beschrieben, von wo ich kein Material besitze. Das einzige am G. Pangerango gesammelte ♀ weicht nach freundlicher Auskunft des Herrn A. GOODSON von einem ♀ des Tring-Museums, das am G. Gedeh gesammelt wurde, dadurch ab, dass Kehle und Brust bei ersterem viel heller grau und die Körperseiten heller braun sind; ferner dadurch, dass der Zügel grau ist wie die Stirn und nicht schwärzlich.
323. *Pteruthius flaviscapis flaviscapis* (TEMME.).  
Flügel ♂ 69-76, ♀ 68-72 mm.

<sup>1)</sup> Beschrieben in: Ornith. Monatsber. Bd. 38, 1930.



324. *Pteruthius aenobarbus aenobarbus* (TEMME).  
Flügel ♂ 60-64, ♀ 58 mm.
325. *Pnoepyga pusilla rufa* SHARPE.  
Flügel 51-55 mm.
326. *Tesia cyaniventris superciliaris* (BP.).  
Flügel 49-52 mm.
- 329d. *Turdus javanicus biesenbachi* STRES. <sup>1)</sup>.  
Aus 2600 m Höhe.
330. *Turdus sibiricus sibiricus* PALL.  
♀ 8. September, ♂ 23. November.
331. *Geocichla citrina rubecula* GOULD.
334. *Oreocincla dauma horsfieldi* BP.  
Flügel 138-142 mm.
336. *Myiophonus glaucinus glaucinus* (TEMME).  
Flügel ad. 140-148 mm.
337. *Enicurus leschenaulti leschenaulti* (VIEILL.).
338. *Enicurus velatus velatus* TEMME.  
Vom 15. Juni 1929 ein Nestjunges.
341. *Notodola diana diana* LESS.  
Flügel ♂ 84-87, ♀ 82 mm.
342. *Saxicola caprata pyrrhonota* (VIEILL.).
347. *Horeites montanus montanus* (HORSF.).  
Flügel ♂ 55-56, ♀ 52 mm.
348. *Phyllergates cucullatus cucullatus* (TEMME).
353. *Prinia familiaris* HORSF.  
1 Nestjunges vom 13. März 1929.
354. *Prinia polychroa* (TEMME).  
Flügel 55, 59 mm.
357. *Megalurus palustris palustris* HORSF.  
Flügel ♂ 96-100 mm.
358. *Phylloscopus trivirgatus trivirgatus* STRICKL.
361. *Hemipus hirundinaceus* (TEMME).  
Flügel ♂ 64-67 mm.
363. *Lanius schach bentet* HORSF.
366. *Crocias guttatus* TEMME.  
Flügel 86-87 mm.
369. *Parus major cinereus* VIEILL.  
Flügel ♂ 65-70, ♀ 63, 64 mm.
- 371a. *Callisitta azurea nigriventer* (ROB. & KLOSS).  
Flügel 76-81 mm. Ganz mit einer Serie vom G. Tjiremai übereinstimmend.
375. *Kitta chinensis thalassina* TEMME.  
Flügel 131-144 mm.

<sup>1)</sup> Beschrieben in: Ornith. Monatsber. Bd. 38, 1930.



380. *Dicrurus leucophaeus leucophaeus* VIEILL.  
 382. *Bhringa remifer remifer* (TEMME).  
 Flügel 125-131 mm.  
 384a. *Oriolus chinensis maculatus* VIEILL.  
 Flügel ♂ ad. 139-145 mm.  
 388a. *Gracupica melanoptera melanoptera* (DAUD.).  
 389. *Aethiopsar grandis javanicus* (CAB.).  
 Flügel ♂ 131-135, ♀ 123-131.  
 390. *Sturnopaster contra jala* (HORSF.).  
 Flügel ♂ 199-123, ♀ 117-121.  
 392. *Gracula javana javana* (CUV.).  
 393. *Aplonis panayensis strigatus* (HORSF.).  
 Nur ein einziges Exemplar neben 9 Exemplaren der folgenden Art!  
 394. *Aplonis minor minor* (BP.).  
 Flügel ♂ ad. 101-106 mm.  
 395. *Passer montanus malaccensis* (DUBOIS).  
 397. *Padda oryzivora* (L.).  
 399. *Munia maja* (L.).  
 401. *Munia leucogastra leucogastroides* HORSF. & MOORE.  
 Flügel 49-50 mm.  
 403. *Chlorura hyperythra hyperythra* REICHENB.  
 Flügel 56-59 mm.  
 404. *Amandava amandava amandava* (L.).  
 409. *Motacilla cinerea caspica* (S. G. GMELIN).  
 Vom 12. und 25. Oktober 1928.  
 414. *Aethopyga eximia* (HORSF.).  
 Flügel ♂ 54-59, ♀ 49-53 mm.  
 418. *Leptocoma jugularis ornata* (LESS.).  
 Flügel ♂ 50-52 mm.  
 421. *Arachnothera longirostra prillwitzii* HART.  
 423. *Arachnothera robusta armata* S. MÜLL.  
 Flügel ♂ 84, 85, ♀ 79 mm.  
 425. *Dicaeum sanguinolentum sanguinolentum* TEMME.  
 Flügel ♂ 46-49 mm.  
 432. *Zosterops parvula gallio* SHARPE.  
 Flügel 51, 53 mm.  
 436b. *Oreosterops javanica javanica* (HORSF.).  
 Flügel 60-65 mm. Ganz mit einer Serie vom G. Tjiremai übereinstimmend.



## ZUR SYSTEMATIK DER ORTHOPTEROIDEN INSEKTEN.

### ZWEITER TEIL.

Von

H. H. KARNY

(Buitenzorg).

Der erste Teil dieser Arbeit ist vor ungefähr zehn Jahren erschienen, und zwar im I. Band der *Treubia* (p. 163 - 269). Ich habe damals versucht, eine phylogenetische Gruppierung der echten Orthopteren zu geben und für die **Thysanoptera** ein detailliertes System samt Genustabelle. Diese entsprach wohl dem damaligen Wissensstande und wurde demgemäß auch von den folgenden Autoren (RAMAKRISHNA AIYAR, WATSON) ausdrücklich als Grundlage angenommen, ist aber heute durch die klassischen Untersuchungen PRIESNERS (1926-1928) schon gänzlich überholt. Ich kann es mir erlassen, hier ein neues Thysanopteren-System zu liefern, da dies ja bereits durch PRIESNER geschehen ist, worauf ich hiemit ausdrücklich hinweise.

Dagegen bedarf in anderer Hinsicht meine damalige Arbeit einer Ergänzung, indem ich nämlich damals die Corrodentia nur ganz kurz und cursorisch auf vier Druckseiten abgetan habe. Ich hätte wohl den Wunsch gehabt, auch das System der Corrodentia mehr im Detail auszuarbeiten, fühlte mich aber damals noch nicht genügend vertraut mit den Copeognathen und konnte doch anderseits auch ENDERLEINS System dieser Gruppe nicht einfach unbesehen akzeptieren. Ueber die **Zoraptera** wußte ich damals aus eigener Erfahrung noch überhaupt nichts. Inzwischen lernte ich aber dann die letztgenannte Gruppe gelegentlich einer Reise nach Südsumatra aus eigener Anschauung kennen und zwar darunter auch ein makropteres Exemplar. Dies gab mir 1922 Veranlassung zu einer phylogenetischen Darlegung, die also als Ergänzung zur „Systematik der Orthopteroiden“ anzusehen ist und worauf ich hier ausdrücklich hinweise. Meinem dort erhaltenen Ergebnis, daß nämlich die Thysanopteren von Zorapteren-ähnlichen Vorfahren abgeleitet werden müssen, hat in der Folge auch PRIESNER zugestimmt (1923, p. 29. 9).

Damit bleibt aber noch immer über die übrigen Corrodentier sehr viel zu sagen übrig. Was die **Isoptera** (Termiten) anlangt, so halte ich HOLMGRENS System wohl für eine den natürlichen Verwandtschaftsverhältnissen entsprechende Anordnung, habe aber schon 1923 (p. 175) ausdrücklich betont, daß seine Familiennamen den Nomenklaturgesetzen durchaus widersprechen, indem nach diesen die Familiennamen stets vom Stamme des typischen Genus durch Anhängung der Endung -idae gebildet werden müssen. Genera namens *Proter-*



*mes*, *Mesotermes* und *Metatermes* existieren jedoch nicht. Somit kann nur HOLMGRENS Familie *Mastotermitidae* unter diesem Namen bestehen bleiben, die übrigen müssen umgetauft werden und zwar

die *Protermitidae* in **Termopsidae nom. nov.**

die *Mesotermitidae* in **Rhinotermitidae nom. nov.**

die *Metatermitidae* in **Termitidae nom. nov.**

Ueber die **Adenopoda** hat inzwischen FRIEDERICH (1923) eine interessante ökologische Arbeit veröffentlicht, in der er auch (p. 28) für die Gruppe den deutschen Namen Spinnfüßler vorschlägt; 1925 bemerkt er dann zu diesem Namen ausdrücklich: „Dieser Name wird für die bisher nur lateinisch benannte Gruppe himit vorgeschlagen.“ Obwohl es ja im allgemeinen nicht üblich ist, sich bei Trivialnamen so sehr die Priorität zu sichern, muß ich doch demgegenüber bemerken, daß die Behauptung gar nicht richtig ist. Der — übrigens sehr nahe liegende — Name Spinnfüßler wurde zu erst von mir vorgeschlagen und zwar bereits 1921 in meiner Terminologie (p. 32) und in der „Natur“ (p. 81), was hiemit gegenüber FRIEDERICH'S Behauptung richtiggestellt sei.

Nun bleibt mir aber noch die Aufgabe, die **Copeognatha** ihrem System nach neu durcharbeiten. Das älteste System der Copeognathen stützte sich (bei KOLBE) sehr mit Recht auf das Flügelgeäder. Demgegenüber schreibt ENDERLEIN 1901: „Viel wichtiger erscheint mir die Anzahl der Tarsenglieder. KOLBE vereinigt Formen mit 2- und 3gliedrigen Tarsen ....., ich halte es für angebracht, die Formen mit 3gliedrigen Tarsen ..... abzutrennen“. Demgemäß teilt ENDERLEIN dann 1903 (Ann. Mus. Hung.) die Gesamtheit der Copeognathen in zwei Hauptabteilungen, nämlich in die Dimera mit zwei Tarsengliedern und in die Trimeria mit dreien bei den Imagines. Später (1909, p. 172) nennt er die ersteren dann Isotecnomera, die letzteren Heterotecnomera. Er scheint dabei die ersteren für die primitiveren zu halten und die Dreigliedrigkeit durch Querteilung des Endgliedes sich entstanden zu denken. Dies entnehme ich daraus, daß er die Dimera voranstellt und bei den Insekten im allgemeinen doch das absteigende System üblich ist, und ferner daraus, daß er 1903 (l.c.p. 193) ausdrücklich bemerkt: „Die Larven und Nymphen von Formen mit dreigliedrigen Tarsen besitzen stets nur zweigliedrige Tarsen, das dritte Glied der Imago entsteht durch Quertheilung des zweiten Tarsengliedes der Larve, die man häufig schon durch die Nymphenhaut hindurch liegen sieht.“ Diese an sich richtige Beobachtung scheint also ENDERLEIN nach dem biogenetischen Gesetz auch auf die Phylogenie übertragen zu haben, obwohl er dies nicht ausdrücklich sagt. Jedenfalls hat auch REUTER die ENDERLEINSche Meinung dahin aufgefaßt, denn sonst hätte er nicht 1904 bei Besprechung von *Leptodella* sagen können: „Nach der Entdeckung der Dreigliedrigkeit der Füße der echten *Leptella* fällt wohl auch jeder Grund für die von Enderlein früher ausgesprochene Ansicht ..... weg, dass „sie eine sehr altertümliche Form darstellt.“ Hätte damals ENDERLEIN, der übrigens mit REUTER in Briefwechsel stand, bezüglich der phylogenetischen Beurteilung der Tarsengliederzahl nicht dieselbe Ansicht gehabt wie REUTER, so hätte er den REUTERschen Angriff sehr leicht dadurch widerlegen können. Aber ENDERLEIN schwieg



darüber! 1911 stellt ENDERLEIN allerdings dann in seinem System ganz richtig die Heterotecnomera an die Wurzel, doch hat er zwischen 1903 und 1911 seine phylogenetischen Anschauungen gründlich geändert, auch in bezug auf das Geäder; doch davon später.

Was nun die Tarsengliederanzahl anlangt, so wissen wir von den Coleopteren und Orthopteroiden her, daß sie uns zwar ein gutes Maß für die Entwicklungshöhe einer Formengruppe abgibt, daß sie aber nicht zur systematischen Abtrennung der einzelnen Entwicklungslinien verwertbar ist, weil sie in den verschiedenen Stämmen von einander unabhängig der Reduktion anheimfällt (vgl. Coleoptera). Daher bei den Käfern die DUMÉRILSche Einteilung auf Grund der Zahl der Tarsenglieder schon längst als nicht den natürlichen Verhältnissen entsprechend aufgegeben worden ist. Zum praktischen Bestimmen ist ja eine Einteilung auf Grund der Tarsengliederzahl sehr geeignet, jedoch durchaus nicht zur Abgrenzung natürlicher Entwicklungslinien. Demgemäß hat kürzlich auch TILLYARD (1926) auf Grund seiner paläontologischen Studien sehr mit Recht das ENDERLEINSche System aufgegeben mit den Worten: „It will be clear from the above that the old classification of the Copeognatha into Dimera (forms with two-segmented tarsi) and Trimera (forms with three-segmented tarsi) cannot stand. The original dichotomy, as shown by the fossils, is provided by the form of the areola postica. The classification already given by me (for Australian and New Zealand forms only) into two suborders, Parapsocida and Eupsocida, will stand provided that the Amphientomidae are added to the former instead of to the latter.“ Ich bin zu einer ganz ähnlichen Anordnung wie TILLYARD auf Grund meiner eigenen Studien an rezenten indonesischen Copeognathen gekommen, wobei mehrere tausend Exemplare durch meine Hand gegangen sind. Auch die Umstellung der Archipsocinen zu den Parapsocida ist ganz nach meinem Sinn, nur den Namen der ganzen Unterordnung halte ich für unpraktisch, weil er zu sehr an die SCUDDERSche Gattung *Paropsocus* erinnert, mit der er natürlich überhaupt nichts zu tun hat.

Wie stellte sich nun aber ENDERLEIN die phylogenetische Entwicklung des Flügelgeäders vor? Er sagt darüber 1903 (l. c. p. 193) wörtlich: „Den primitiven Flügeln fehlt das Geäder völlig, oder es ist nur primitiv ausgebildet, während die durch wirkliche Rückbildung entstandenen Flügelrudimente meist das ganze Adersystem aufweisen.“ Danach müßte man folgern, daß wir es beispielsweise bei *Archipsocus* (l. c. p. 283, fig. 1; pl. VIII fig. 50a) nicht mit einem rückgebildeten, sondern mit einem ursprünglich einfachen Geäder zu tun haben. Davon kann natürlich gar keine Rede sein. Denn da müßten ja die Copeognathen (im Gegensatz zu sämtlichen anderen Insektenordnungen!) von einer Stammgruppe mit wenig entwickeltem Geäder abstammen!! Dagegen sind wir der Ueberzeugung, daß sie von mehr oder weniger Blattoiden-ähnlichen Vorfahren herzuleiten sind, also von Formen mit ziemlich dichtem, netzartigem Geäder. Allerdings hat ENDERLEIN 1911 (p. 293) seine frühere Anschauung schon berichtigt, wenn er sagt: „Die Thylacinen sind die unbeschuppten Vorläufer der übrigen 3 Familien und wohl die phylogenetisch ältesten Vertreter der Copeognathen,



obgleich sie durch die zugespitzten Flügel etwas abgeleitet erscheinen; von diesem ältesten Zweige ist aber doch ein Vertreter mit breitem runden Flügel vorhanden und zwar die rezente Gattung *Soa* ENDERL. 1904, zieht man noch hinzu, daß *Soa* die einzige Gattung ist, bei der der proximale und distale Teil der zerrissenen *Subcosta* durch Vermittlung einer Querader verbunden werden, so ist die Annahme berechtigt, daß eine unbeschuppte *Soa* mit dem Urtypus aller bekannten Copeognathen zusammenfällt." Diese Äußerung nimmt sich doch schon wesentlich anders aus als die über die „primitiven“ Flügel von 1903! Tatsächlich stimme ich auch mit ENDERLEIN dahin überein, daß „eine unbeschuppte *Soa*“ uns einen sehr ursprünglichen Copeognathentypus darstellen würde; immerhin wäre es aber noch nicht der Urtypus.

Denn wir kennen rezente Copeognathen mit reichlicher entwickeltem Geäder, das sicherlich nicht als sekundär verzweigt angesehen werden darf. Ich verweise hier nur darauf, daß bei *Calopsocus* (ENDERLEIN l.c. pl. VI fig. 22a; 1904 pl. 7 fig. 1; BANKS 1916 pl. I, fig. 1; KARNY 1925 pl. 3 fig. 2) noch ein dichtes Adernetzwerk an den Vorderflügeln vorhanden ist, ganz wie wir es für die Zwischenstufe zwischen Blattoiden-ähnlichen Vorfahren und höher entwickelten Copeognathen voraussetzen müssen. Auch ist die Verzweigung der Hauptadern noch eine viel reichlichere als bei den jüngeren Formen, die Media dichotom vierästig und die Areola postica macht noch durchaus den Eindruck einer einfachen Gabelzelle des Cubitus und hat noch gar nicht die später für die höher entwickelten Copeognathen (Lachesillidae, Psocidae) charakteristische Form. In ganz ähnlicher Weise verhält sich auch der Vorderflügel von *Neurosema* (ENDERLEIN 1903 l.c., pl. V fig. 21a, VI fig. 21b). Daß bei diesen Formen die Fühler schon auf dreizehn Glieder reduziert und die Tarsen nur mehr zweigliedrig sind, ist allerdings eine sekundäre Spezialisierung (Spezialisationskreuzung!). Aber davon abgesehen, muß ich auf Grund des Flügelgeäders die beiden genannten Gruppen für die primitivsten rezenten Copeognathen halten und stelle sie daher unter diesen als Neurosemidae an den Anfang des Systems. ENDERLEIN faßt sie 1911 mit den Dypsocini zur Unterfamilie Dypsocinae zusammen, welche er als abgeleiteten Zweig der Caeciliidae betrachtet, „der aber viel ursprüngliches im Geäder enthält.“ Bei ihnen ist das Hinterhaupt kantenartig geschärft und die Fühler sind meist verdickt oder doch auffallend dicht behaart. Meiner Ansicht nach haben wir auch in diesen Merkmalen bemerkenswerte Charaktere zu sehen. Denn bei den Blattoiden ist infolge der Ventralstellung des Kopfes sehr oft das Hinterhaupt mit einer Querkante versehen und auch die verdickten und dicht behaarten Fühler finden wir bei einigen höher stehenden Gattungen (*Hemithyrsocera*, *Pseudothyrsocera*, *Pseudomops*, *Paratropes* u.s.w.). Bei den Blattoiden ist diese Spezialisierung zweifellos nicht monophyletisch entstanden, sondern in den verschiedenen Unterfamilien selbständig von einander und lag somit bereits in der ganzen Entwicklungstendenz; wir dürfen uns daher nicht wundern, wenn wir bei den relativ ursprünglichsten Copeognathen auch dieselbe Tendenz wiederum antreffen. Der Zuteilung der Neurosemiden zu den Caeciliiden bei ENDERLEIN vermag ich nicht zu folgen, denn das Geäder erweist sich bei



ersteren als bedeutend primitiver, die Areola postica hat eine durchaus abweichende Gestalt und ist auch durch Queradern mit der Media verbunden, so daß man beim praktischen Bestimmen viel eher auf Psociden als auf Caeciliiden kommen würde. Auch ist noch keine ausgesprochen deutliche Pterostigmabildung vorhanden, sondern bloß die erste Anlage einer solchen, wie es ja übrigens bei gewissen Blattoiden auch schon vorkommt.

Das Vorstehende schrieb ich, als mir TILLYARDS paläontologische Untersuchungen noch nicht zugänglich waren. Durch diese sehe ich meine Auffassung nun durchaus bestätigt; denn wir haben dadurch nun in den „*Permopsocida*“ eine Copeognathengruppe kennen gelernt, welche zweifellos, wie TILLYARD zeigte, dem „Archetype of the Order“ entspricht und die den Calopsocinen und Neuroseminen im Geäder so nahe kommt, daß ich mich genötigt sehe, diese gleichfalls zu den Permopsocida zu stellen. Daß bei ihnen keine Cerci und nur zweigliedrige Tarsen vorhanden sind, ist lediglich ein Zeichen höherer Spezialisierung, welche aber nichts daran ändert, daß wir sie als direkte Abkömmlinge des Permopsocida-Stammes ansehen müssen und nicht mit den Caeciliidae in nähere phylogenetische Beziehung bringen können, bloß deshalb, weil diese Zeichen höherer Spezialisierung sich in beiden Linien parallel und gleichsinnig entwickelt haben.

Wenn wir nun im Stammbaum absteigend weiterschreiten, so schließen sich zunächst an die Permopsocida (deren Urformen TILLYARD uns ja langfühlerig und mit fünf Tarsengliedern ausgestattet kennen gelehrt hat) jene Gruppen an, deren Vorderflügel noch kein stärker chitinisiertes Pterostigma aufweisen. Hieher gehören als ein sehr primitiver Seitenzweig, wie gleichfalls TILLYARD (1928) festgestellt hat, die Delopteridae. Bezüglich ihrer systematischen Stellung kommt TILLYARD zu dem Resultat „that the family Delopteridae does not lie in the direct ancestral line of any existing group. It has some relationships with the Embiaria, and some with the Copeognatha; of all known insects, it is certainly closest to the family Psocidiidae of the suborder Permopsocida of the Copeognatha, and is more especially close to the genus *Dichentomum* Till., already recognized as the most primitive of all known Copeognatha. I therefore propose that the group be retained for the present as a special side-branch of the order Copeognatha, ..... and suggest the name Embiopsocida for the group, to be regarded for the present as of subordinal value only.“ Ich stimme dem wieder durchaus zu, wenn mir auch der Name *Embiopsocida* unpraktisch erscheint, weil er zu sehr an die Gattung *Embiopsocus* erinnert; immerhin behalte ich diesen Gruppennamen wie oben Parapsocida aus Prioritätsgründen bei, um nicht durch Neubenennung eine noch größere Verwirrung zu stiften. MARTYNOV hat (1926) unter dem Namen *Lithentomum* (nec SCUDDER 1867; = *Lithopsocus mihi nom. nov.*) ein zweifellos hieher gehöriges Insekt beschrieben, das er mit Perientominae, Lepidopsocidae, Empheriidae, Amphientomidae und Psyllipsocidae vergleicht, kurz durchwegs mit Formen der Parapsocida TILLYARDS, zu denen sicherlich auch wirklich gewisse nähere



Beziehungen bestehen; er errichtet für dieses Genus die Familie Lithentomidae, die nunmehr in die Synonymik von Delopteridae zu verweisen ist.

TILLYARD charakterisiert seine *Parapsocida* vor allem durch die Form der Areola postica, womit er vom phylogenetischen Standpunkt zweifellos recht hat, was aber beim praktischen Bestimmen des öfteren gewisse Schwierigkeiten bereiten dürfte, da wir ja unter den Lachesilliden (speziell bei den Epipsocini) Formen antreffen, die eine (allerdings sekundär) flache Areola postica aufweisen. Ich ziehe daher für die Praxis des Bestimmens das noch nicht stark chitinierte Pterostigma als Bestimmungsmerkmal vor. Für die Entwicklung der Areola postica hat TILLYARD übrigens (1926, Amer. J. Sci. p. 317, fig. 2) eine sehr instruktive Darstellung gegeben. Bei den meisten Parapsocida ist, wie ja zu erwarten, der Tarsus noch dreigliedrig und die Fühler lang und vielgliedrig. Vielfach sind die Flügel sekundär reduziert oder ganz verloren gegangen. Wenn sie vorhanden sind, zeichnen sie sich durch den Mangel eines stärker chitinierten Pterostigmas und auch noch dadurch aus, daß die Areola postica noch nicht die für die höheren Copeognathen typische Form hat, sondern noch die einer einfachen Gabelzelle des Cubitus, wobei seine beiden Gabeläste einen spitzen bis beinahe rechten Winkel mit einander einschließen,  $Cu_1$  die ungefähre Verlängerung des Cubitusstammes bildet und  $Cu_2$  schräg oder beinahe senkrecht gegen den Hinterrand hinzieht. Vielfach treten Aderreduktionen oder -verschmelzungen auf; Multiramie kommt nicht vor. Unter diesen Formen sind zweifellos jene die höher entwickelten, welche beschuppte Flügel aufweisen, die mit kahlen oder bloß behaarten Flügeln sind die ursprünglicheren. Letztere bezeichne ich als die Familie der Trogiidae, erstere als Amphientomidae.

Als die primitivste Subfamilie der Trogiidae betrachte ich die *Thylacinae* mit den Tribus *Thylacini* und *Udamolepidini*, welche zweifellos der Wurzel der rezenten Copeognathen noch recht nahe stehen. Nur die auffallende Zuspitzung der Flügel ist eine sekundäre Spezialisierung, die schon an bestimmte beschuppte Formen (Perientominae) erinnert. Dem gegenüber haben sich die *Empheriinae* noch zweifellos ursprünglichere Flügelform erhalten, sind aber im Geäder schon etwas weiter spezialisiert. Ihnen schließen sich die *Psoquilinae* an, bei denen die Flugorgane schon stark in Reduktion begriffen sind. Noch weiter geht die Reduktion bei den *Trogiinae*. Dagegen sind die *Psyllipsocinae* wieder geflügelt, ihr Geäder erweist sich aber gegenüber den *Empheriinae* durch die Nodulusbildung als höher spezialisiert. Im weiteren Verlauf der Entwicklung ist eine Reduktion der Fühlerglieder eingetreten und zwar bei den *Troctinae* zunächst auf 15. Bei dieser Gruppe sind auch die Flügel oder doch mindestens ihr Geäder (*Embidopsocini*) einer sehr starken Reduktion anheimgefallen. Bei den *Electrentominae* sind die Flügel wieder besser entwickelt, aber die Fühlerglieder schon auf 13 verringert. Ihnen schließen sich die flügellosen *Pseudopsocinae* an, die ENDERLEIN in seinem System überhaupt nicht anführt; bei ihnen sind die Fühler gegenüber der vorigen Gruppe noch weiter verkürzt. Weiterhin ist auch eine Reduktion der Tarsengliederzahl eingetreten; denn auf die *Pseudopsocinae* lasse ich die



*Archipsocinae* folgen, die ENDERLEIN — offenbar mit Unrecht — bei den Caeciliiden untergebracht hat, ein Irrtum, der übrigens schon durch TILLYARD (1926, l. c. p. 347-349) richtig gestellt worden ist. Ihre Flügel sind stark reduziert, lassen aber doch noch ein Geäder erkennen, bei dem sich die *Areola postica* noch sehr primitiv verhält und keine deutliche Pterostigmabildung vorhanden ist. Zwischen den *Pseudopsocinae* und *Archipsocinae* mögen die *Prionoglarinae* ihren Platz finden.

Zu den *Amphientomidae* rechne ich alle beschuppten Formen, also die *Perientominae*, *Lepidillinae* und *Amphientominae*; auch hier zeigt uns die Entwicklung denselben Weg wie bei der vorigen Gruppe: von den primitiven *Perientominae* durch Flügelreduktion zu den *Lepidillinae*, durch Fühlerreduktion zu den *Amphientominae*.

Nun folgen — als im allgemeinen höher spezialisiert — alle jene Copeognathengruppen (= *Eupsocida* TILLYARD), bei denen eine deutliche Pterostigmabildung erkennbar ist. Sie sind vermutlich unabhängig von den *Parapsocida* aus den *Permopsocida* hervorgegangen, denn ihr Geäder erinnert noch in mancher Hinsicht an diese; vor allem durch gelegentlich auftretende Vielästigkeit. Die Multiramie betrachte ich durchwegs als ursprünglichen Charakter und kann mir eine sekundäre Entstehung von zahlreichen Ästen aus wenigen überhaupt nicht vorstellen. Darum sehe ich auch jene Formen als die ursprünglichsten an, bei denen das Geäder noch reichlich entwickelt ist. Dies ist der Fall bei den *Stenopsocidae* durch Vorhandensein einer Verbindung zwischen Pterostigma und Radius. Die relativ ursprünglichste Gruppe ist hier — von der Zweigliedrigkeit der Tarsen abgesehen — die Subfamilie der *Callistopterinae*; bei ihnen verhält sich die *Areola postica* noch ganz primitiv als ausgesprochene Gabelzelle des Cubitus, wie bei den *Neurosemidae*. Das Pterostigma ist bei ihnen mit dem vordersten Radii-Sektor-Ast eine Strecke weit verschmolzen. Bei allen jetzt folgenden Gruppen der Copeognathen hat die *Areola postica* nicht mehr ihre ursprüngliche Form (wie bei den *Neurosemidae* und *Callistopterinae*) bewahrt, sondern ist ungefähr halbkreisförmig geworden, wobei der Hinterast des Cubitus das Aussehen einer kurzen, zum Hinterrand ziehenden Querader annimmt. Die stark konvexe Krümmung des Cubitus-Vorderastes erkläre ich mir entwicklungsgeschichtlich durch eine zur Media ziehende Querader; wir können nämlich bei Geäderstudien fast durchgehend beobachten (in den verschiedensten Insektengruppen), daß Queradern scheinbar einen elastischen Zug auf die Längsadern ausüben und so sehen wir denn in sehr vielen Fällen an der Einmündungsstelle einer Querader die betreffende Längsader stumpfwinkelig geknickt. So kommt die für die höheren Copeognathen ursprünglich charakteristische Form der „gestielten“ *Areola postica* zustande (TILLYARD, 1926, Am. J. Sci., p. 317, fig. 2 C!), deren Cubitus-Vorderast an der Einmündungsstelle der Querader (= des Stieles) winkelig geknickt ist. Dies sehen wir sehr deutlich bei den *Permopsocida*: die *Psocidiidae* besitzen eine *Areola postica*, die noch dem *Parapsocida*-Typus entspricht (einfache flache Gabelzelle des Cubitus), während bei den *Permopsocidae* schon



der soeben erwähnte Typus auftritt, also nicht der Lachesilliden-ähnliche, welcher letzterer meiner Ueberzeugung nach vielmehr vom Stenopsociden-Typus abzuleiten ist. Die gestielte Form ist nämlich für die *Propsocinae* und *Stenopsocinae* typisch, aber auch für gewisse *Myopsocinae* (z. B. *Lichenomina*) und *Psocinae* (z. B. *Hemipsocus*, *Clematoscenea*). Von hier kann nun die Entwicklung der Areola postica in zweierlei verschiedenen Richtungen weitergehen: entweder 1) die Querader (= der „Stiel“) wird verkürzt und zwar schließlich bis zu ihrem völligen Verschwinden, so daß dann die Areola postica die Media in einem Punkte berührt (TILLYARD l. c. fig. 2 D) oder auf eine weitere Strecke (l. c. fig. 2 E) mit der Media verschmilzt (wie bei den meisten *Psocidae*) oder 2) diese Querader geht wieder gänzlich verloren und ihr früheres Vorhandensein wird uns nur noch durch die stark konvexe Krümmung (besonders bei *Kolbia*, *Dasypsocus* etc.) des Cubitus-Vorderastes angedeutet, welche auch weiterhin nach Verlust der Querader mehr oder weniger ausgeprägt erhalten geblieben ist (wie bei den meisten *Lachesillidae*). Schließlich haben wir dann auch noch die Familie der *Peripsocidae*, bei welcher überhaupt keine Areola postica vorhanden ist.

Auf Grund des soeben gesagten lasse ich also innerhalb der *Stenopsocidae* auf die *Callistopterinae* die *Propsocinae* folgen, welche das vorhin geschilderte, offenbar aus dem Callistopterinen-Geäder hervorgegangene Stenopsocinen-Geäder aufweisen, sich aber durch ihre noch dreigliedrigen Tarsen als relativ ursprüngliche Gruppe erweisen. Sodann die *Stenopsocinae* mit gleichem Geäder, aber schon zweigliedrigen Tarsen. Endlich stelle ich hierher als höchst entwickelten Zweig die *Bertkauinae*, welche gleichfalls zweigliedrige Tarsen aufweisen, sich durch die flügellosen ♀♀ aber als höher spezialisiert erweisen, und bei denen (♂) außerdem auch die Areola postica zwar noch stark konvex ist, aber schon ihre Verbindung mit der Media verloren hat.

Als nächste Familie betrachte ich nun die *Psocidae*, bei denen die Areola postica mit der Media noch verbunden ist, während das Pterostigma keine Verbindung mehr mit dem Radii Sektor besitzt; immerhin ist bei einigen relativ ursprünglichen Formen ein Rudiment einer solchen Querader noch erkennbar, welches ihr früheres Vorhandensein beweist (so bei *Clematostigma* und *Copostigma*). Als ursprünglichste Subfamilie müssen wir auf Grund ihrer noch dreigliedrigen Tarsen die *Myopsocinae* betrachten, denen dann die *Psocinae* mit schon zweigliedrigen Tarsen folgen; hier können wir die *Psocini* mit dreiästiger Media der Vorderflügel von den *Hemipsocini* unterscheiden, bei denen die Media schon auf zwei Äeste reduziert ist. Eine besondere Spezialisierung des Psociden-Typus zeigen die *Thyrsophorinae*, bei denen der hinterste Sektorast an der Basis so stark nach hinten konvex vorspringt, daß er die Media berührt oder mit ihr durch eine kurze Querader verbunden ist. Die Gruppe ist ausgesprochen neotropisch, mit einziger Ausnahme der Gattung *Cycetes* ENDERLEIN (syn. *Goya* NAVÁS), welche offenbar aus diesem Grunde von ENDERLEIN zu den *Psocinae* gestellt worden war, während sie NAVÁS auf Grund der morphologischen Merkmale allein mit Recht zu den *Thyrsophorinen*



rechnet; dieser Fall zeigt uns, daß aus dem Psocinen-Geäder der Thyrsophorinen-Typus offenbar polytopisch entstanden ist. Als ursprünglichste Form der Thyrsophorinen betrachte ich auf Grund des zum Teil noch netzförmigen Vorderflügelgeäders die Gattung *Dictyopsocus*, welche wie übrigens auch andere Angehörige der Gruppe mit den primitiven Neurosemiden auch noch durch die verdickten Fühler übereinstimmt. Die Formen mit gewöhnlich gestalteten Vordertibien (*Ischnopterygini*) sind natürlich ursprünglicher als die mit spezialisierten (*Thyrsophorini*).

Bei den *Lachesillidae*<sup>1)</sup> unterscheide ich wieder die ursprünglicheren Subfamilien mit drei Fußgliedern von den höher entwickelten mit nur noch zweien. Von den ersteren betrachte ich als die primitivsten die *Ptiloneurinae*, welche „in dem Besitze einer 2. Axillarader einen sehr altertümlichen Charakter“ (ENDERLEIN 1911) sich erhalten haben; auch die häufige Multiramie in dieser Gruppe ist zweifellos ein relativ ursprüngliches Merkmal. Dem gegenüber sind die *Elipsocinae* mit ihrer niemals mehr als dreiästigen Media schon weiter entwickelt, wie uns auch die häufige Flügellosigkeit der ♀♀ in dieser Gruppe erkennen läßt. In bezug auf dieses letzt genannte Merkmal schließen sich ihnen die *Reuterellinae* an, welche schon einen zweigliedrigen Tarsus haben. Viel ursprünglicher als diese letztgenannten sind die *Dypsocinae*, die im Gesamthabitus und namentlich durch den Kopf- und Fühlerbau an die Neurosemidae anschließen, dem Geäder nach aber unbedingt hier ihren Platz finden müssen. Die *Xenopsocinae* sind unter den *Lachesilliden* mit zweigliedrigem Tarsus das Pendant zu den *Ptiloneurinae* — auf Grund ihrer (zweifellos ursprünglichen) Multiramie; und schließlich folgen als höchst stehende Gruppe hier die *Lachesillinae*; die lang gestreckte, flache Form der Areola postica, die bei *Pseudocaecilius* ihren Ausgang nimmt und sich dann über *Epipsocus* und *Polypsocus* in *Monocladellus* zu ihrem Extrem steigert, halte ich nicht für ursprünglich, sondern sicher für sekundäre Spezialisierung — gegenüber der ursprünglichen Flachheit bei *Archipsocus*, der daher auch zu den Trogiiidae versetzt werden muß (s. oben).

Unter den Formen ohne Areola postica endlich — den *Peripsocidae* — unterscheide ich die *Neurostigmatae* von den in bezug auf ihr Geäder schon stark reduzierten *Peripsocinae*.

Ich komme damit nach dem bisher gesagten zur Aufstellung des folgenden Systems der Copeognathen.

### Systematische Uebersicht der Copeognathen.

#### Schlüssel zur Bestimmung der Familien.

1. Mehrgliedrige Cerci vorhanden; Tarsen, soweit bekannt, fünfgliedrig. Fossile Formen aus dem Perm und Mesozoicum.
2. Radii Sektor der Vorderflügel nur einfach gegabelt. Vorderer Cubitusast

<sup>1)</sup> Daß der bisher übliche Familienname *Caeciliidae* durch die gleichnamige Amphibiengruppe präokkupiert ist, darauf hat jüngst COCKERELL (Entomologist, LXII, p. 19; 1929) hingewiesen. Den von COCKERELL dafür vorgeschlagenen Namen *Peripsocidae* kann ich aber für diese Gruppe nicht akzeptieren, da ich darunter eine andere, getrennte Familie verstehe. Auch ist der Name *Lachesilla* älter als *Peripsocus*.



nach Abgang der Media noch im Apikalteil einfach gegabelt und somit eine primitive Areola postica bildend.

3. Areola postica am Vorderflügel flach, etwa zwei bis dreimal so lang wie hoch, mit der dichotom vierästigen Media nicht verbunden. .... I. Familie **Psocidiidae**.

3'. Areola postica des Vorderflügels mit der Media durch eine Querader verbunden.

4. Areola postica fast immer kürzer als hoch. Media des Vorderflügels dichotom vierästig. .... II. Familie **Permopsocidae**.

4'. Areola postica deutlich länger als hoch. Media des Vorderflügels nur dreiästig, d.h. der Vorderast der Hauptgabelung bleibt einfach und nur ihr Hinterast ist nochmals gegabelt.

III. Familie **Martynopsocidae**.

2'. Radii Sektor der Vorderflügel dreiästig, d.h. in einen einfach gegabelten Vorderast und einen einfachen Hinterast geteilt. Nur ganz ausnahmsweise (*Permembia*, *Lithopsocus*) bloß einfach gegabelt; in diesem Falle aber dann der Vorderast des Cubitus nach Abhang der Media einfach bleibend, daher keine Areola postica vorhanden. ....

V. Familie **Delopteridae**.

1'. Cerci gänzlich fehlend. Tarsen zwei- bis dreigliedrig. Tertiäre und rezente, sowie einige mesozoische Formen.

2. Vorderflügel zum Teil mit engmaschigem netzartigem Geäder. Hinterkopf mit scharfer Querkante und die Fühler mehr oder weniger verdickt oder mindestens auffallend stark behaart. IV. Familie **Neurosemidae**.

2'. Hinterhaupt ohne Querkante und die Fühler nicht auffallend verdickt oder Vorderflügelgeäder weitmaschig, mit nur sehr wenigen Queradern.

3. Flügel oft verkümmert oder fehlend; wenn vorhanden, Pterostigma dünnhäutig wie die übrige Flügelfläche.

4. Flugorgane, wenn vorhanden, nicht beschuppt. ....

VI. Familie **Trogiidae**.

4'. Flugorgane gut entwickelt oder mitunter nur als kleine Lappen vorhanden, stets deutlich beschuppt. ....

VII. Familie **Amphientomidae**.

3'. Flügel beim ♂ stets vorhanden, mit deutlich chitinisiertem Pterostigma.

4. Pterostigma mit dem Radii Sektor durch eine deutliche, durchlaufende Querader verbunden oder mit seinem vordersten Ast eine Strecke weit verwachsen. . . VIII. Familie **Stenopsocidae**.

4'. Pterostigma frei, ohne Verbindung mit dem Radii Sektor.

5. Flügel mit deutlicher Areola postica oder beim ♀ fehlend.

6. Areola postica mit der Media deutlich verwachsen oder (seltener) mindestens durch eine Querader verbunden. .... IX. Familie **Psocidae**.



- 6'. Areola postica frei, keinesfalls mit der Media verbunden. .... X. Familie **Lachesillidae**.  
 5'. Flügel in beiden Geschlechtern entwickelt, ohne Areola postica. .... XI. Familie **Peripsocidae**.

### Bestimmungstabellen für die Subfamilien und Tribus.

#### A. PERMOPSOCIDA.

##### I. Familie **Psocidiidae**.

Keine Gruppenunterteilung.

##### II. Familie **Permopsocidae**.

Keine Gruppenunterteilung.

##### III. Familie **Martynopsocidae**.

Keine Unterteilung.

##### IV. Familie **Neurosemidae**.

1. Drittes und viertes Fühlerglied verdickt und dicht pubesziert; Geäder s. ENDERLEIN 1903, Ann. Mus. Hung. pl. V fig 21 a, VI fig. 21 b; und NAVÁS 1924, p. 138 fig. 7. .... 1. Subfamilie **Neuroseminae**.
- 1'. Drittes und viertes Fühlerglied nicht wesentlich verdickt, aber ziemlich dicht behaart. Geäder s. ENDERLEIN l. c. pl. VI fig. 22 a; BANKS 1916, pl. I fig. 1. .... 2. Subfamilie **Calopsocinae**.

#### B. EMBIOPSOCIDA.

##### V. Familie **Delopteridae**.

Keine Gruppenunterteilung.

#### C. PARAPSOCIDA.

##### VI. Familie **Trogiidae**.

1. Fühler mindestens fünfzehngliedrig.
2. Fühler einundzwanzig- bis fünfziggliedrig. Zweites Glied der Maxillarpalpen mit einem kolbenförmigen Sinnesorgan.
3. Flügel verkümmert oder ausgebildet, die beiden Analadern (An und Ax) am Vorderflügelrand nicht in einem Punkte endigend.
4. Mindestens die Vorderflügel gut entwickelt und mit Adern versehen.
5. Flügel deutlich zugespitzt, dicht behaart, aber ohne Schuppen. .... 1. Subfamilie **Thylacinae**.



- 6.  $M_3$  des Vorderflügels distal vom Rs aus dem Mediastamm abgehend. .... Tribus a) **Thylacini**.
- 6'.  $M_3$  des Vorderflügels knapp vor dem Rs aus dem Mediastamm abgehend. Tribus b) **Udamolepidini**.
- 5'. Flügel am Ende abgerundet.
- 6. Hinterflügel entwickelt, fast so groß wie die vorderen.
  - 2. Subfamilie **Empheriinae**.
- 7. Media im Vorderflügel dreiästig.
  - Tribus a) **Empheriini**.
- 7'. Media im Vorderflügel zweiästig.
  - Tribus b) **Rhypsocini**.
- 6'. Hinterflügel gänzlich fehlend oder nur stummelartig ausgebildet. .... 3. Subfamilie **Psoquillinae**.
- 4'. Vorderflügel kurz, schuppenförmig, ganz ohne Adern. ....
  - 4. Subfamilie **Trogiinae**.
- 5. Letztes Maxillarpalpenglied kurz und dick; Mittelsegment als deutliches Segment ausgebildet. ....
  - Tribus a) **Trogiini**.
- 5'. Letztes Maxillarpalpenglied lang; Mittelsegment kurz und schmal, nur als sehr zartes Skelettstück erkennbar.
  - Tribus b) **Lepinotini**.
- 3'. Flügel stets ausgebildet, die beiden Analadern (An und Ax) am Vorderflügelrande in einem Punkte (= Nodulus) endigend. ....
  - 5. Subfamilie **Psyllipsocinae**.
- 4. Media nach Abgang des Cubitus im Vorderflügel selber noch gegabelt.
  - 5. Die Querader zwischen Rs und Media steht im Vorderflügel basal von der Mediagabelung. ....
    - Tribus a) **Psyllipsocini**.
  - 5'. Die Querader zwischen Rs und Media steht im Vorderflügel distal von der Hauptgabelung der Media. ....
    - Tribus b) **Archipsyllini**.
- 4'. Media der Vorderflügel nach Abgang des Cubitus einfach bleibend. .... Tribus c) **Allopsocini**.
- 2'. Fühler fünfzehngliedrig. Zweites Glied des Maxillarpalpus ohne kolbenförmiges Sinnesorgan. .... 6. Subfamilie **Troctinae**.
- 3. Flügel vorhanden, länger als der Hinterleib, nur mit zwei Längsadern, von denen die zweite (= Media) stets einfach ist, während die vordere (= Radius) einfach gegabelt sein kann (in Radius und Radii Sektor); Ocellen vorhanden. .... Tribus a) **Embidopsocini**.
- 3'. Flügel fehlend oder nur die vorderen vorhanden (*Sphaeropsocus*, ENDERLEIN 1911 pl. XXVI fig. 97) und dann gewölbt, deckenartig, mit mehreren Längsadern.



- 4. Prothorax oben dreilappig. Keine Scheitelnahrt. Hinterschenkel stark keulig verbreitert und mit dem Trochanter verwachsen. Tribus b) **Troctini.**
- 4'. Prothorax ungeteilt. Scheitelnahrt vorhanden. Hinterschenkel stark keulig verbreitert und nicht mit dem Trochanter verwachsen. Tribus c) **Pachytroctini.**
- 1'. Fühler dreizehngliedrig.
- 2. Tarsen der Imagines dreigliedrig.
- 3. Fühler ausgesprochen länger als der Kopf. Flügel voll entwickelt. 7. Subfamilie **Electrentominae.**
- 3'. Fühler kaum länger als der Kopf. Flügellos. 8. Subfamilie **Pseudopsocinae.**
- 2'. Tarsen der Imagines nur zweigliedrig.
- 3. Fühler ausgesprochen länger als der Kopf. 9. Subfamilie **Prionoglarinae.**
- 3'. Fühler kaum länger als der Kopf. 10. Subfamilie **Archipsocinae.**

## VII. Familie **Amphientomidae.**

- 1. Fühler einundzwanzig- bis fünfziggliedrig. Die beiden Analadern (An und Ax) am Vorderflügelrand nicht in einem Punkte endigend oder die Flügel überhaupt verkümmert. Prothorax von oben sichtbar und mehr oder weniger groß und frei entwickelt.
- 2. Flugorgane vollkommen entwickelt. ... 1. Subfamilie **Perientominae.**
- 3. Hinterflügel mit langer, schmaler, geschlossener Radialzelle. Vorderflügel nur im Costalfeld mit Makrochäten. Fühler mit zwanzig bis fünfundzwanzig langen Gliedern. ... Tribus a) **Perientomini.**
- 3'. Hinterflügel ohne geschlossene Radialzelle. Vorderflügel auch auf den Adern mit Makrochäten. Fühler mit über dreißig ziemlich kurzen Gliedern.
- 4. Radii Sektor einfach gegabelt. Hinterflügel vollständig entwickelt. Tribus b) **Echmepterygini.**
- 4'. Radii Sektor einfach. Hinterflügel stark reduziert, ohne Adern, oder gänzlich fehlend. Tribus c) **Echinopsocini.**
- 2'. Flugorgane zu kleinen Lappen verkümmert. 2. Subfamilie **Lepidillinae.**
- 1'. Fühler dreizehngliedrig. Die beiden Analadern (An und Ax) am Vorderflügelrande in einem Punkte (= Nodus) endigend. Prothorax von oben nicht sichtbar, sondern vom Mesothorax nach unten gedrückt. 3. Subfamilie **Amphientominae.**
- 2. Radii Sektor am Vorderflügel distalwärts von der Mediagabelung aus dem Mediastamm abgehend. Media des Hinterflügels gegabelt. Tribus a) **Cymatopsocini.**



- 2'. Radii Sektor am Vorderflügel basalwärts von der Mediagabelung aus den Mediastamm abgehend. Media des Hinterflügels einfach. ....  
Tribus b) **Amphientomini.**

## D. EUPSOCIDA.

### VIII. Familie **Stenopsocidae.**

1. Pterostigma mit dem Vorderast des Radii Sektors am Vorderflügel verschmolzen. Areola postica deutlich als Gabelzelle entwickelt, mit spitzem Winkel an der Cubitusgabelung, nicht mit der Media verbunden. ....  
1. Subfamilie **Callistopterinae.**
- 1'. Pterostigma mit dem Radii Sektor des Vorderflügels durch eine deutliche, durchlaufende Querader verbunden. Areola postica ungefähr halbkreisförmig, mit ziemlich stumpfem Winkel an der Cubitusgabelung, in der Regel mit der Media durch eine Querader verbunden.
2. Flügel in beiden Geschlechtern vollkommen entwickelt. Areola postica mit der Media verbunden.
3. Tarsen dreigliedrig. .... 2. Subfamilie **Propsocinae.**
- 3'. Tarsen zweigliedrig. .... 3. Subfamilie **Stenopsocinae.**
- 2'. Areola postica mit der Media nicht verbunden. Flügel nur beim ♂ vorhanden, beim ♀ fehlend. Tarsen zweigliedrig. ....  
4. Subfamilie **Bertkauinae.**

### IX. Familie **Psocidae.**

1. Tarsen dreigliedrig. .... 1. Subfamilie **Myopsocinae.**
- 1'. Tarsen auch bei der Imago zweigliedrig.
2. Radii Sektor der Vorderflügel stets frei, nicht mit der Media verwachsen; Geäder nicht dicht netzartig. .... 2. Subfamilie **Psocinae.**
3. Media der Vorderflügel dreiästig ..... Tribus a) **Psocini.**
- 3'. Media der Vorderflügel nur zweiästig ... Tribus b) **Hemipsocini.**
- 2'. Hinterster Sektorast am Vorderflügel nahe der Basis mit der Media verwachsen oder durch eine auffallende kurze Querader verbunden, oder das Geäder zum Teil dicht netzartig. ... 3. Subfamilie **Thyrsophorinae.**
3. Vordertibien von der üblichen Gestalt. Tribus a) **Ischnopterygini.**
- 3'. Vordertibien sehr stark flach gedrückt und verbreitert. ....  
Tribus b) **Thyrsophorini.**

### X. Familie **Lachesillidae.**

1. Tarsen der Imagines dreigliedrig.
2. Vorderflügel mit drei Anales ( $An$ ,  $Ax_1$ ,  $Ax_2$ ) und einer vier- bis acht-ästigen Media. .... 1. Subfamilie **Ptiloneurinae.**
- 2'. Vorderflügel mit nur zwei Anales ( $An$  und  $Ax$ ) und einer bloß dreiästigen Media. Beim ♀ die Vorderflügel öfters verkümmert. ....  
2. Subfamilie **Elipsocinae.**



- 1'. Tarsen der Imagines zweigliedrig.
2. Flügel beim ♀ vollständig verkümmert. 3. Subfamilie **Reuterellinae.**
- 2'. Flügel in beiden Geschlechtern vollständig entwickelt.
3. Hinterhaupt mit scharfer Querkante. Fühler stark verdickt, dicht behaart. .... 4. Subfamilie **Dypsocinae.**
- 3'. Hinterhaupt abgerundet. Fühler nicht ungewöhnlich verdickt.
4. Vorderflügel: Vorderast des Radii Sektors selber nochmals gegabelt; Media vierästig oder ein Teil der Vorderflügelfläche mit dendritisch verzweigten Adern. ....
5. Subfamilie **Xenopsocinae.**
- 4'. Radii Sektor des Vorderflügels nur einfach gegabelt; Media höchstens dreiästig. Keine dendritischen Aderverzweigungen.
6. Subfamilie **Lachesillinae.**
5. Radii Sektor und Media des Vorderflügels mit einander durch eine Querader verbunden. Tribus a) **Epipsocini.**
- 5'. Radii Sektor und Media des Vorderflügels mit einander eine Strecke weit verschmolzen. Tribus b) **Lachesillini.**

## XI. Familie **Peripsocidae.**

1. Pterostigma mit deutlicher, kräftiger Queraderung. Media mit mehr als drei Aesten. .... 1. Subfamilie **Neurostigminae.**
- 1'. Pterostigma ohne Queradern. Media nur dreiästig.
2. Subfamilie **Peripsocinae.**

Ich gebe nun eine Aufzählung der im vorstehenden aufgestellten Gruppen samt Liste der zu ihnen gehörigen Genera, wobei ich bei jedem Genus gleichzeitig auf die instruktivsten und besten Figuren hinweise, soweit sie mir in der mir vorliegenden Literatur zugänglich sind.

## Systematisches Verzeichnis der Genera.

### A. PERMOPSOCIDA.

#### I. Familie **Psocidiidae.**

*Dichentomum* TILLYARD 1926 (Amer. Journ. Sci., p. 320 fig. 3), *Permentomum* TILLYARD 1926 (l.c.p. 336 fig. 13), *Pentapsocidium* TILLYARD 1926 (l.c.p. 334 fig. 12), *Psocidium* TILLYARD 1926 (l.c.p. 322-329 figs. 4-9), *Chaetopsocidium* TILLYARD 1926 (l.c.p. 331 fig. 10), *Metapsocidium* TILLYARD 1926 (l.c.p. 333 fig. 11).

#### II. Familie **Permopsocidae.**

*Progonopsocus* TILLYARD 1926 (Amer. Journ. Sci., p. 338 fig. 14), *Permopsocus* TILLYARD 1926 (l.c.p. 340-343 figs. 15-18), *Ancylopsocus* TILLYARD 1926 (l.c.p. 345 fig. 19).



III. Familie **Martynopsocidae**.

**Martynopsocus** **nom. nov.** f. *Dinopsocus* MARTYNOV 1928 nec BANKS 1920 (MARTYNOV 1928, pl. VII fig. 2).

IV. Familie **Neurosemidae**.1. Subfamilie **Neuroseminae**.

*Neurosema* McLACHLAN 1866 (ENDERLEIN 1903, Ann. Mus. Hung., pl. V fig. 21a, VI fig. 21b). Dirla NAVÁS 1924 (p. 138 fig. 7).

2. Subfamilie **Calopsocinae**.

*Calopsocus* HAGEN 1866 (ENDERLEIN 1903, Ann. Mus. Hung., pl. VI fig. 22a; 1904 pl. 7 fig. 1; BANKS 1916, pl. I fig. 1; KARNY 1925, pl. 3 fig. 2).

## B. EMBIOPSOCIDA.

V. Familie **Delopteridae**.

*Delopsocus* TILLYARD 1928 (p. 475-478 figs. 4-9), *Delopterum* SELLARD (TILLYARD l.c.p. 472-473 figs. 1-3), *Permembia* TILLYARD 1928 (p. 479-480 figs. 10-11), **Lithopsocus** **nom. nov.** f. *Lithentomum* MARTYNOV 1926 nec SCUDDER 1867 (MARTYNOV 1926, p. 1366 fig. 9).

## C. PARAPSOCIDA.

VI. Familie **Trogiidae**.1. Subfamilie **Thylacinae**.Tribus a) **Thylacini**.

*Thylax* HAGEN 1866, *Thylacella* ENDERLEIN 1911 (pl. XXVI fig. 96).

Tribus b) **Udamolepidini**.

*Udamolepis* ENDERLEIN 1912 (p. 301-302 figs. 1-2).

2. Subfamilie **Empheriinae**.Tribus a) **Empheriini**.

*Trichempheria* ENDERLEIN 1911 (pl. XXV fig. 80), *Empheria* HAGEN 1856 (ENDERLEIN 1911, pl. XXV fig. 82), *Bebiosis* ENDERLEIN 1911 (pl. XXV fig. 81).

Tribus b) **Rhypsocini**.

*Deipnopsocus* ENDERLEIN 1903 (Zool. Jahrb., pl. 17 fig. 4), *Empheriella* ENDERLEIN 1912, *Rhypsocopsis* PEARMAN 1929 (p. 109 figs. 3 a, b), *Rhypsocus* HAGEN 1876, *Psylloneura* ENDERLEIN 1903 (Ann. Mus. Hung., pl. XI fig. 58 c), *Eosilla* RIBAGA 1908 (pl. II), *Tapinella* ENDERLEIN 1908 (Zool. Anz., p. 774 fig. 1).

3. Subfamilie **Psoquillinae**.

*Psocatropos* RIBAGA 1899 (ENDERLEIN 1927, VII 14 fig. 32), *Psoquilla* HAGEN 1866 (= *Psocinella* BANKS 1900 = *Axinopsocus* ENDERLEIN 1903; v. ENDERLEIN 1908, Zool. Anz., p. 780 figs. 1-12; 1919, pl. V fig. 31; 1927, VII 14 fig. 31), *Dorypteryx* AARON 1883 (pl. IX figs. 2, 3; ENDERLEIN 1927, VII 14 fig. 33).



4. Subfamilie **Trogiinae**.Tribus a) **Trogiini**.

Trogium ILLIGER 1798 (= *Atropos* LEACH 1815 = *Clothilla* WESTWOOD 1841; v. ENDERLEIN 1905, pl. I figs. 3,5; 1927, VII 15 fig. 37; TILLYARD 1923, p. 176 fig. 3), Myopsochne Enderlein 1905 (p. 17 fig. 3, p. 20 fig. 5), Myrmicodipnella Enderlein 1909 (Boll. Portici, p. 336-337 figs. 1-3), Hyperetes Kolbe 1880 (= *Tichobia* Kolbe 1882 = *Cerobasis* Kolbe 1887 = *Albardia* Jacobson & Bianchi 1905; v. ENDERLEIN 1903, Zool. Jahrb., pl. 19 fig. 13).

Tribus b) **Lepinotini**.

Lepinotus Heyden 1850 (= *Paradoxides* Motschulsky 1851 = *Paradoxenus* Motschulsky 1852; v. ENDERLEIN 1905 pl. I figs. 1, 2, 6-8; 1927, VII 15 figs. 34-36; TILLYARD 1923, p. 176 fig. 4).

5. Subfamilie **Psyllipsocinae**.Tribus a) **Psyllipsocini**.

Psyllipsocus Sélys-Longchamps 1872 (Reuter pl. III figs. 5-7; Enderlein 1903, Ann. Mus. Hung., pl. XI figs. 59 a, b; 1927, VII 13 fig. 29), Paremptheria Enderlein 1906 (Stett. Entom. Z., p. 307 fig. 1), Nymphopsocus Enderlein 1903 (Zool. Jahrb., pl. 43), Scolipsyllopsis Enderlein 1912 (1919, pl. IV fig. 21, pl. V fig. 30; 1927, VII 18 fig. 28).

Tribus b) **Archipsyllini**.

Archipsylla Handlirsch 1908 (pl. XLIII fig. 45; Enderlein 1909, Zool. Anz., p. 772 fig. 1).

Tribus c) **Allopsocini**.

Allopsocus Banks 1920 (pl. I figs. 10, 11).

6. Subfamilie **Troctinae**.Tribus a) **Embidopsocini**.

Embidopsocus Hagen 1865 (Enderlein 1905, p. 52 fig. 11), Embidotroctes Enderlein 1905 (p. 50 fig. 10, pl. IV), Semnopsocus Laing 1925 (p. 290 figs. A-L).

Tribus b) **Troctini**.

Troctes Burmeister 1839 (= *Liposcelis* Motschulsky 1852; v. Enderlein 1905, pl. III figs. 26, 27; 1927, VII 13 figs. 26, 27), Trigonosceliscus Enderlein 1910 (Naturforsch. Fr., p. 76 figs. 9, 10), Stenotroctes Enderlein 1905 (pl. III figs. 28-33), Eutroctes Ribaga 1911 (p. 166 fig. 7), Tropusia Hagen 1883.

Tribus c) **Pachytroctini**.

Pachytroctes Enderlein 1905 (pl. I fig. 9; Ribaga 1911, p. 157-161 figs. 1-4), Psacadium Enderlein 1908, Peritroctes Ribaga 1911 (p. 164 fig. 5), Palaeotroctes Enderlein 1911 (pl. XXVI fig. 102), Sphaeropsocus Hagen 1882 (Enderlein 1911 pl. XXVI fig. 97), Nanopsocus Pearman 1928 (p. 136 fig. 3), Cuixa Navás 1927 (p. 152 fig. 2).

7. Subfamilie **Electrentominae**.

Electrentomum Enderlein 1911 (pl. XXIV figs. 70-76, XXV fig. 79).

8. Subfamilie **Pseudopsocinae**.

Pseudopsocus Kolbe 1882 (Pearman 1924, p. 123 fig.).



9. Subfamilie **Prionoglarinae**.

Prionoglaris ENDERLEIN 1909 (Biospeol., pl. XVIII fig. 1).

10. Subfamilie **Archipsocinae**.

Archipsocus HAGEN 1882 (ENDERLEIN 1903, Ann. Mus. Hung., p. 283 fig. 1, pl. VIII; 1906, Zool. Jahrb., pl. 6 figs. 3-19), Chaetopsocus PEARMAN 1929 (p. 109 figs. 1a-d).

VII. Familie **Amphientomidae**.1. Subfamilie **Perientominae**.Tribus a) **Perientomini**.

Soa ENDERLEIN 1904 (pl. 7 fig. 2), Perientomum HAGEN 1865 (ENDERLEIN 1906, Spol. Zeyl., pl. B figs. 9-14), Lepium ENDERLEIN 1906 (l.e., pl. B fig. 15, C fig. 16), Notolepium ENDERLEIN 1910, Nepticulomima ENDERLEIN 1906 (l.e., pl. C figs. 17-21).

Tribus b) **Echmepterygini**.

Lepidopsocus ENDERLEIN 1903 (Ann. Mus. Hung., pl. IX fig. 62 a, XI fig. 62b), Thylacomorpha ENDERLEIN 1912, Thylacopsis ENDERLEIN 1911 (1908, Voeltzkow, pl. XI fig. 14), Echmepteryx AARON 1886 (ENDERLEIN 1906, Spol. Zeyl., pl. C figs. 22, 23), Oxypsocus TILLYARD 1923 (p. 179 figs. 5, 6).

Tribus c) **Echinopsocini**.

Echinopsocus ENDERLEIN 1903 (Ann. Mus. Hung., pl. XI fig. 63 b), Seolopama ENDERLEIN 1906 (Spol. Zeyl., pl. F fig. 108), Pteroxanium ENDERLEIN 1922 (p. 113 figs. 1-6; 1927 VII 16 fig. 38).

2. Subfamilie **Lepidillinae**.

Lepidilla RIBAGA 1905, Lepolepis ENDERLEIN 1906 (Spol. Zeyl., pl. C fig. 24).

3. Subfamilie **Amphientominae**.Tribus a) **Cymatopsocini**.

Cymatopsocus ENDERLEIN 1903 (Ann. Mus. Hung., pl. IX fig. 56 a, XI fig. 56c), Tineomorpha ENDERLEIN 1906 (Spol. Zeyl., pl. A fig. 1).

Tribus b) **Amphientomini**.

Palaeoseopsis ENDERLEIN 1925 (1906, Spol. Zeyl., p. 60 fig. 1; 1911, pl. XXV fig. 78), Amphientomum PICTET 1854 (ENDERLEIN 1903, Ann. Mus. Hung., pl. XI fig. 55), Paramphientomum ENDERLEIN 1906 (Spol. Zeyl., pl. A fig. 7, D fig. 27), Hormocoria ENDERLEIN 1926, Seopsis ENDERLEIN 1906 (Spol. Zeyl., pl. A figs. 4-6), Stimulopalpus ENDERLEIN 1906 (l.e., pl. C figs. 127-130), Hemiseopsis ENDERLEIN 1906, Colposeopsis ENDERLEIN 1910, Stigmatopathus ENDERLEIN 1903 (Ann. Mus. Hung., pl. IX fig. 57 a, XI fig. 57 b), Syllysis HAGEN 1866 (ENDERLEIN 1906, Spol. Zeyl., pl. A figs. 2-3).

## D. EUPSOCIDA.

VIII. Familie **Stenopsocidae**.1. Subfamilie **Callistopterinae**.

Callistoptera ENDERLEIN 1903 (Ann. Mus. Hung., pl. V fig. 23), Harpezoneura ENDERLEIN 1909 (p. 272 fig. 2), Pentathyrsus ENDERLEIN 1912.



2. Subfamilie **Propsocinae**.

*Propsocus* MC LACHLAN 1866.

3. Subfamilie **Stenopsocinae**.

*Stenopsocus* HAGEN 1866 (TÜMPEL pl. XXIII fig.; ENDERLEIN 1906, Zool. Jahrb., pl. 10 figs. 5-7), *Graphopsocus* KOLBE 1880 (forma brachyptera = *Teratopsocus* REUTER 1893; v. TÜMPEL pl. XXIII fig.; ENDERLEIN 1927 VII 5 fig. 10).

4. Subfamilie **Bertkauinae**.

*Bertkauia* KOLBE 1882 (= *Lapithes* BERTKAU 1882; v. ENDERLEIN 1919, p. 22 fig. 3; 1927 VII 7 figs. 13-14).

IX. Familie **Psocidae**.1. Subfamilie **Myopsocinae**.

*Myopsocus* HAGEN 1866 (ENDERLEIN 1906, Zool. Jahrb., pl. 11 fig. 13), *Lichenomima* ENDERLEIN 1910 (1919 pl. IV fig. 20), *Phlotodes* ENDERLEIN 1910 (1903, Ann. Mus. Hung., pl. IX fig. 51 a), *Rhaptoneura* ENDERLEIN 1910, *Lophopterygella* ENDERLEIN 1907 (= *Festona* NAVÁS 1920, p. 60 fig. 5; ENDERLEIN 1908, Voeltzkow, pl. XI figs. 10-11), *Tricladellus* ENDERLEIN 1909 (= *Tricladus* ENDERLEIN 1906, Zool. Jahrb., pl. 23 fig. 6), *Pentacladus* ENDERLEIN 1906 (Zool. Jahrb., pl. 23 fig. 7).

2. Subfamilie **Psocinae**.

Tribus a) **Psocini**.

*Clistopsocus* NAVÁS 1924 (p. 65 fig. 6), *Euclismia* ENDERLEIN 1925 (1903, Ann. Mus. Hung., pl. IV fig. 14, XIV fig. 70; 1906, Zool. Jahrb., pl. 23 figs. 1, 4; 1927 VII 4 fig. 7), *Loensia* ENDERLEIN 1924 (1919, pl. I figs. 3, 7; 1927 VII 5 fig. 9; TÜMPEL, pl. XXIII fig. links), *Psocus* LATREILLE 1796 (TÜMPEL, pl. XXIII fig.; ENDERLEIN 1903, Ann. Mus. Hung., pl. IV figs. 9-11, 13; 1927 VII 4 figs. 4,5), *Nescus* NAVÁS 1925 (p. 198 fig. 23), *Podopterocus* BANKS 1920 (pl. I fig. 4), *Amphigerontia* KOLBE 1880 (TÜMPEL, pl. XXIII fig. rechts; ENDERLEIN 1927 VII 5 fig. 8), *Sigmatina* ENDERLEIN 1925 (BANKS 1920, pl. II fig. 19), *Titella* NAVÁS 1912 (p. 197 fig. 5), *Neopsocus* KOLBE 1882 (= *Barnola* NAVÁS 1909; v. ENDERLEIN 1900, pl. 9 fig. 12; 1927 VII 4 fig. 6), *Blaste* KOLBE 1883, *Trichadenotectum* ENDERLEIN 1909 (1919, pl. V fig. 26), *Valenzuela* NAVÁS 1924 (p. 21 fig. 1), *Clematoscenea* ENDERLEIN 1907 (1903, Ann. Mus. Hung., pl. IV fig. 8), *Mecampsis* ENDERLEIN 1925, *Brachinodiscus* ENDERLEIN 1925 (1900, pl. 9 fig. 11), *Copostigma* ENDERLEIN 1903 (Ann. Mus. Hung., pl. IV fig. 15), *Clematostigma* ENDERLEIN 1906 (1903, Ann. Mus. Hung., pl. IV figs. 12, 16, XIV fig. 73; 1906, Zool. Jahrb., pl. 23 fig. 3), *Ptycta* ENDERLEIN 1925 (1920, pl. 5), *Dinopsocus* BANKS 1920 (pl. 2 fig. 24, pl. 3 fig. 25), *Sigmatoneura* ENDERLEIN 1908 (1903, Ann. Mus. Hung., pl. IV fig. 7; OKAMOTO 1908, pl. II fig. 6), *Cerastipsocus* KOLBE 1884 (= *Cerastis* KOLBE 1883; v. RIBAGA 1908, pl. VI fig. 2), *Eremopsocus* MC LACHLAN 1866 (= *Syngonosoma* KOLBE 1883), *Lasiopsocus* ENDERLEIN 1907 (1919, pl. III fig. 15), *Kodamaius* OKAMOTO 1908 (pl. II figs. 2, 7), *Matsumuraiella* ENDERLEIN 1906 (Zool. Jahrb., pl. 10 fig. 3), *Steleops* ENDERLEIN 1910, *Diplacanthoda* ENDERLEIN 1909, *Pelmatocoria* ENDER-



LEIN 1910, Taeniosigma ENDERLEIN 1901 (pl. 34 fig. 9; 1903, Ann. Mus. Hung., pl. V fig. 18).

Tribus b) **Hemipsocini.**

Hemipsocus SÉLYS-LONGCHAMPS 1872 (ENDERLEIN 1903, Ann. Mus. Hung., pl. IV fig. 17a; 1919, pl. V fig. 29), Anopistoscenea ENDERLEIN 1912.

3. Subfamilie **Thyrsophorinae.**

Tribus a) **Ischnopterygini.**

Dietyopsocus ENDERLEIN 1901 (pl. 34 fig. 8; 1919, pl. IV fig. 18), Ischnopteryx ENDERLEIN 1900 (pl. 8 fig. 2; 1903, Zool. Jahrb., pl. 17 fig. 1), Colpostigma ENDERLEIN 1925 (BANKS 1924, pl. 2 fig. 8), Thyrsopsocus ENDERLEIN 1900 (pl. 8 figs. 3-8), Cycetes ENDERLEIN 1907 (= *Goya* NAVÁS 1927, p. 39 fig. 1; ENDERLEIN 1907, p. 109 fig. 1).

Tribus b) **Thyrsophorini.**

Gigantopsocus ENDERLEIN 1925, Thyrsophorus BURMEISTER 1839 (ENDERLEIN 1900 pl. 8 fig. 1).

## X. Familie Lachesillidae.

1. Subfamilie **Ptiloneurinae.**

Ptiloneura ENDERLEIN 1900 (pl. 9 fig. 14), Euplocania ENDERLEIN 1910 (p. 70 fig. 1), Loneura NAVÁS 1927 (p. 50 fig. 8), Goja NAVÁS 1927 (p. 51 fig. 9).

2. Subfamilie **Elipsocinae.**

Cabarer NAVÁS 1908 (p. 410 fig. 12), Mesopsocus KOLBE 1880 (= *Trocticus* BERTKAU = *Holoneura* TETENS 1891; v. ENDERLEIN 1927 VII 10 fig. 20; TILLYARD 1923, p. 185 fig. 11), Labocoria ENDERLEIN 1910, Hexacyrtoma ENDERLEIN 1908 (Jena, pl. XIX fig. 1), Hemineura TETENS 1891 (ENDERLEIN 1911, pl. III fig. 13; REUTER, pl. II fig. 2), Actenotarsus ENDERLEIN 1907 (Zool. Jahrb., pl. 19), Elipsocus HAGEN 1866 (ENDERLEIN 1903, Zool. Jahrb., pl. 19 figs. 12, 14, 15; 1927 VII 10-11 figs. 21-23), Kilauella ENDERLEIN 1913 (1920, pl. 6 figs. 8-13), Palistreptus ENDERLEIN 1920 (pl. 6 figs. 14, 15), Philotarsus KOLBE 1880 (ENDERLEIN 1903, Ann. Mus. Hung., pl. IX fig. 53; TILLYARD 1923, p. 181 fig. 7, p. 182 fig. 8), Psilopsocus ENDERLEIN 1903 (Ann. Mus. Hung., pl. XIV fig. 74, Leptodella REUTER 1904 (= *Leptella* REUTER 1893; v. 1904, pl. I figs. 4-12, II fig. 1; ENDERLEIN 1901, Zool. Jahrb., pl. 34 figs. 1, 2; 1927 VII 11 figs. 24, 25), Philotarsopsis TILLYARD 1923 (p. 183 fig. 9), Zelandopsocus TILLYARD 1923 (p. 184 fig. 10).

3. Subfamilie **Reuterellinae.**

Belapha ENDERLEIN 1917 (p. 258 figs. 1-3), Reuterella ENDERLEIN 1903 (GUERMONPREZ 1906, pl. I; ENDERLEIN 1927 VII 6 figs. 11-12).

4. Subfamilie **Dypsocinae.**

Dypsocus HAGEN 1866 (ENDERLEIN 1903, Ann. Mus. Hung., pl. V fig. 24; OKAMOTO 1910, pl. III fig. 1), Coryphaca ENDERLEIN 1910, Protodypsocus ENDERLEIN 1903 (Ann. Mus. Hung., pl. XIII fig. 66), Coryphocopis ENDERLEIN 1926, Coryphosimila ENDERLEIN 1925, Mepachycera ENDERLEIN 1925.

5. Subfamilie **Xenopsocinae.**

Xenopsocus KOLBE 1885 (pl. IV B fig. 2), Dendroneura ENDERLEIN 1903.



6. Subfamilie **Lachesillinae.**Tribus a) **Epipsocini.**

Epipsocus HAGEN 1866 (ENDERLEIN 1903, Ann. Mus. Hung., pl. VI fig. 31; 1911, pl. XXI figs. 7-10), Hageniella ENDERLEIN 1903 (Ann. Mus. Hung., pl. V figs. 25-27; 1919, pl. V figs. 24, 25), Polypsocus HAGEN 1866 (= *Ptilopsocus* ENDERLEIN 1900; v. 1900, pl. 9 figs. 17-21; 1919, pl. IV figs. 22, 23), Monocladellus ENDERLEIN 1909 (Stett. Ent. Z., p. 267 fig.).

Tribus b) **Lachesillini.**

Amphipsocus MC LACHLAN 1872 (KOLBE 1885, pl. IV fig. 3; ENDERLEIN 1908, Voeltzkow, pl. XI figs. 3, 5), Fülleborniella ENDERLEIN 1902 (1903, Ann. Mus. Hung., pl. VII fig. 36; 1908, Voeltzkow, pl. XI fig. 4), Maoripsocus TILLYARD 1923 (p. 191 fig. 16), Caecilius CURTIS 1837 (ENDERLEIN 1903, Ann. Mus. Hung., pl. VII figs. 34-35, 37-43, 79; 1927 VII 8 figs. 15-16), Hemicaecilius ENDERLEIN 1903 (Zool. Jahrb., pl. 17 fig. 9; KARNY 1925, pl. 3 fig. 7), Mesocaecilius OKAMOTO 1910 (pl. III fig. 6), Kolbia BERTKAU (= *Kolbea* ENDERLEIN 1906, Zool. Jahrb., pl. 11 fig. 11; OKAMOTO 1910, pl. IV fig. 3; KARNY 1925 pl. 3 fig. 6), Ophiodopelma ENDERLEIN 1908 (1903, Ann. Mus. Hung., pl. XIV fig. 72), Dasypsocus ENDERLEIN 1906 (Zool. Jahrb., pl. 11 fig. 10; 1903, Ann. Mus. Hung., pl. V fig. 32), Dasydemella ENDERLEIN 1909, Cladioneura ENDERLEIN 1906 (Zool. Jahrb., pl. 26 fig. 5), Ptenolasia ENDERLEIN 1911 (pl. XXIII fig. 4b), Pseudocaecilius ENDERLEIN 1903 (Ann. Mus. Hung., pl. V figs. 28-30), Trichopsocus KOLBE 1882, Palaeopsocus KOLBE 1883 (ENDERLEIN 1911, pl. XXIV figs. 50-51), Lachesilla WESTWOOD (= *Pterodela* KOLBE 1880 = *Leptopsocus* REUTER 1904, pl. II fig. 5 = *Graphocaecilius* ENDERLEIN 1900, pl. 9 fig. 23; 1919, p. 16 figs. 1, 2; 1927 VII 8 fig. 17), Tagalopsocus BANKS 1916 (pl. I figs. 9, 10), Ptenopsila ENDERLEIN 1923 (p. 247 fig. 5), Mepleres ENDERLEIN 1926 (OKAMOTO 1910, pl. III fig. 5).

XI. Familie **Peripsocidae.**1. Subfamilie **Neurostigminae.**

Neurostigma ENDERLEIN 1900 (pl. 9 fig. 24).

2. Subfamilie **Peripsocinae.**

Peripsocus HAGEN 1866 (ENDERLEIN 1903, Ann. Mus. Hung., pl. VII figs. 44-46; 1927 VII 9 fig. 18), Ectopsocus MC LACHLAN 1899 (= *Micropsocus* ENDERLEIN 1901; v. 1903, Ann. Mus. Hung., pl. VII figs. 47-49; 1927 VII 9 fig. 19), Peripsocopsis TILLYARD 1923 (p. 194-195 figs. 18-20).

In der vorstehenden Genus-Aufzählung wurde *Paropsocus* SCUDDER 1890 (Tertiary Insects, p. 118, pl. V fig. 51) nicht angeführt, weil SCUDDERS Angaben nicht ausreichen, um dem Genus im System einen sicheren Platz anzuweisen. Außerdem wurden die folgenden Genera nicht aufgenommen, weil mir ihre Originalbeschreibungen nicht zugänglich waren:



1913. *Vulturops* TOWNSEND, Ent. News, XXIII, p. 269.

1913. *Fita* NAVÁS, Rev. Ac. Madrid, XII, p. 333.

1913. *Marcenendius* NAVÁS, Rev. Ac. Madrid, XII, p. 334.

1913. *Notiopsocus* BANKS, Psyche, XX, p. 84.

1915. *Fabrella* LACROIX, Bull. Soc. Ent. France, p. 194.

Zwecks leichteren Auffindens der aufgezählten Genera folge hier nun noch für die Copeognathen ein

### INDEX GENERUM.

Dabei bedeutet Cursivdruck Synonyma; die römische Ziffer deutet die Familie, die arabische die Subfamilie an, die kleinen Buchstaben dagegen die Tribus.

<i>Actenotarsus</i> ENDERLEIN .....	X.2.	<i>Clematostigma</i> ENDERLEIN ...	IX.2 a)
<i>Albardia</i> JACOBSON & BIANCHI	VI.4 a)	<i>Clistopsocus</i> NAVÁS .....	IX.2 a)
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<i>Palaeoseopsis</i> ENDERLEIN .....	VII.3 b)	<i>Ptiloneura</i> ENDERLEIN .....	X.1.
<i>Palaeotroctes</i> ENDERLEIN .....	VI.6 c)	<i>Ptilopsocus</i> ENDERLEIN .....	X.6 a)
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<i>Prionoglaris</i> ENDERLEIN .....	VI.9.	<i>Tapinella</i> ENDERLEIN .....	VI.2 b)
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<i>Pseudocaecilius</i> ENDERLEIN ....	X.6 b)	<i>Thylax</i> HAGEN .....	VI.1 a)
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<i>Psocatropos</i> RIBAGA .....	VI.3.	<i>Tichobia</i> KOLBE .....	VI.4 a)
<i>Psocidium</i> TILLYARD .....	I.	<i>Tineomorpha</i> ENDERLEIN .....	VII.3 a)
<i>Psocinella</i> BANKS .....	VI.3.	<i>Titella</i> NAVÁS .....	IX.2 a)
<i>Psocus</i> LATREILLE .....	IX.2 a)	<i>Trichadenotecnum</i> ENDERLEIN	IX.2 a)
<i>Psoquilla</i> HAGEN .....	VI.3.	<i>Trichempheria</i> ENDERLEIN ...	VI.2 a)
<i>Psyllipsocus</i> SÉLYS-LONGCH. ...	VI.5 a)		
<i>Psylloneura</i> ENDERLEIN .....	VI.2 b)		



Trichopsocus KOLBE .....	X.6 b)	Udamolepis ENDERLEIN .....	VI.1 b)
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<i>Tricladus</i> ENDERLEIN .....	IX.1.	Valenzuela NAVÁS .....	IX.2 a)
Trigonosceliscus ENDERLEIN ...	VI.6 b)	Vulturops TOWNSEND .....	?
Troctes BURMEISTER .....	VI.6 b)		
<i>Trocticus</i> BERTKAU .....	X.2.	Xenopsocus KOLBE .....	X.5.
Trogium ILLIGER .....	VI.4 a)		
Tropusia HAGEN .....	VI.6 b)	Zelandopsocus TILLYARD .....	X.2.

Was nun die Frage einer eventuellen Weiterentwicklung des Copeognathenstammes nach oben anlangt, so läßt uns jetzt die Entdeckung der Permopsocida durch TILLYARD die Annahme möglich erscheinen, doch vielleicht auch die Zoraptera vom Copeognathenstamm abzuleiten, wie dies CRAMPTON und — offenbar ihm folgend — IMMS (p. 283, 284) getan haben. Vor Entdeckung der Permopsocida schien eine solche Ableitung wegen der zwischen den bis dahin bekannten Copeognathen und Zorapteren bestehenden Spezialisationskreuzung unmöglich. Auch die Ableitung der Thysanopteren von Zorapteren erscheint jetzt ganz leicht denkbar, denn die bisher bestehende Schwierigkeit der Ableitung der Terebrantia von ovipositorlosen Zorapteren ist nun behoben, da die Permopsocida ja eine Legeröhre besaßen, wir also recht wohl berechtigt sind anzunehmen, es könne auch unter den Zorapteren Formen mit Ovipositor geben oder doch gegeben haben.

Daß von Copeognathen-ähnlichen Vorfahren höchstwahrscheinlich die **Anoplura** abzuleiten sind, habe ich schon im ersten Teil dieser Arbeit (1921) betont. Bemerken möchte ich hier nur nebenbei, daß IMMS (p. 290) „Anopleura“ schreibt, was sprachlich ein Unsinn ist (denn mit Pleuren hat der Name nicht das mindeste zu tun!), aber auch historisch unrichtig; denn der Name wurde von LEACH — offenbar im Gegensatz zu den LATREILLESchen Thysanura — für jene (parasitischen) Formen der LINNAEUSschen Apteren aufgestellt, welche ein unbewehrtes Hinterleibsende haben, daher Anoplura von  $\alpha\nu$  = alpha privativum,  $\sigma\pi\lambda\alpha$  = Waffen,  $\omicron\upsilon\rho\acute{\alpha}$  = Schwanz, wogegen Thysanura von  $\theta\acute{\upsilon}\sigma\alpha\nu\omicron\varsigma$  = herabhängende Verzierungen, Quaste,  $\omicron\upsilon\rho\acute{\alpha}$  = Schwanz. Dieser Ableitung zufolge ist eine Schreibung wie Anopleura absolut unmöglich und gänzlich sinnlos.

BÖRNER hat sich wiederholt bemüht, den Beweis zu erbringen, daß wir die Mundteile der Rhynchoten über die der Thysanopteren von denen der Copeognathen ableiten können. Damit soll natürlich nicht behauptet sein, daß die Thysanopteren den Uebergang von den letzteren zu den ersteren vermitteln und die Rhynchoten somit von ihnen abstammen, sondern nur daß die Rhynchoten-Mundteile über eine Thysanopteren-ähnliche Zwischenstufe von Copeognathen abgeleitet werden könnten. Es handelt sich also hier nicht um eine direkte Ahnenreihe, sondern lediglich um eine Anpassungsreihe im Sinne ABELS. Wenn ich auch nach wie vor auf dem Standpunkte stehe, daß wir die Zwischenform zwischen den Palaeodictyopteren und Heteropteren in *Eugereon* zu sehen haben, so



kann ich mich anderseits doch nicht der auffallenden und weitgehenden Aehnlichkeit des Copeognathengeäders mit dem gewisser Psylliden verschließen, auf die auch CRAMPTON wiederholt hingewiesen hat. Diese Aehnlichkeit scheint mir doch — wenn das Geäder in phylogenetischen Fragen überhaupt noch als verlässliches Merkmal angesehen werden soll — auf eine wirkliche Verwandtschaft hinzuweisen. Mit den Psylliden wären dann natürlich auch die Aleyrodiden, Aphididen und Cocciden von Copeognathen-ähnlichen Vorfahren abzuleiten — da die Verwandtschaft dieser vier Familien ja zu augenfällig ist und auch noch nie von jemandem bestritten worden ist; übrigens hat PATCH an der Hand des Geäders auch noch ausdrücklich ihre Zusammengehörigkeit dargelegt. Danach läge also der Gedanke nahe, diese vier Familien (= Sternorhyncha = Phytophthires) von den übrigen Rhynchoten abzutrennen und von Copeognathen-ähnlichen Vorfahren abzuleiten.

Dagegen hat aber CRAWFORD, der beste Psyllidenkenner, betont (p. 16): "It seems apparent from the morphological studies on this family that it is less closely related to the Aphididae, Aleyrodidae, and Coccidae than has been heretofore supposed. Many things point to a close relationship with the higher Homoptera, especially the Cicadoidea, and the Membracidae, and related families." Wenn dies richtig ist, so müßten wir also dann auch die Auchenorhyncha (Cicadoidea s. l.) von Copeognathen-ähnlichen Vorfahren ableiten, natürlich nicht über die Psylliden, sondern von ursprünglichen, reichlicher geäderten Formen, wie wir sie beispielsweise in den Permopsocida kennen gelernt haben. Dann blieben also für die Ableitung von *Eugereon* nur noch die eigentlichen Wanzen übrig, wobei aber zu betonen ist, daß vielleicht noch manche bisher zu den Wanzen gerechnete Formen in die Verwandtschaft der Zikaden werden gestellt werden müssen (z. B. Corixidae; Peloridiidae, teste MYERS & CHINA 1929; &c). Wenn die vorstehenden Betrachtungen richtig sind, so hätten wir also dann das Ergebnis, daß wir die bisherigen Rhynchoten als eine diphyletische Gruppe betrachten müßten, die in zwei Teile zerlegt werden muß, von denen der eine von *Eugereon*, der andere von Permopsocida herzuleiten wäre.

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